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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

U.S. Battleship Colorado.

Turbines at the Raanaasfoss Power Station, Norway.

Pneumatic Grain Elevators—No. III.

Recent Progress in Gears and Gear Cutting.

Electric Lifts.

Methods of Manufacture.

A Very Large Surface Condenser.

A Roller Bearing Oil Engine.

The Railway Strike.

PUBLIC NOTICES

Sale by Tender.

TENDERS are INVITED for the PURCHASE, DISMANTLING and REMOVAL of PLANT (one Marine Type Dry-back Boiler), lying at the Head Post-office, Manchester.

Tenders will be received until 10 a.m. on Thursday, the 31st January, 1924.

Forms of Tender, containing all particulars, can be obtained on application to the CONTROLLER, Post Office Stores Department, Studd-street Depot, Islington, London, N. 1.

The Postmaster-General does not bind himself to accept the highest or any Tender.

By Order of the POSTMASTER-GENERAL.

General Post Office, January, 1924. 4690

The Director-General, India Store Department, Branch No. 16, Belvedere-road, Lambeth, S.E. 1, REQUIRES:—

SPRINGS, HELICAL, for RAILWAY WAGONS.

Tenders due on the 5th February, 1924.

Tender forms obtainable from above. 4742

Architectural Draughts-MEN REQUIRED for GOVERNMENT DEPARTMENTS.

Candidates should have served in H.M. Forces during the war, have had good training in Civil Engineers' or Architects' Offices, and be fully capable of preparing working drawings and specifications for general civil engineering or architectural work. Employment will be for varying periods, and must not be regarded as permanent.

Salary according to qualifications, but in general not exceeding £300 per annum.

Written applications, with full details of experience and qualifications, should be addressed to the JOINT SUBSTITUTION BOARD (Treasury and Ministry of Labour), Montagu House, Whitehall, S.W. 1.

Replies will be sent only to such candidates as it is proposed to interview. 4689

Assistant Engineer for Railway Survey REQUIRED by the NIGERIAN GOVERNMENT for a tour of 12 to 18 months' service. Salary £540, rising to £720 by annual increments of £30, and thence to £920 by annual increments of £40. Outfit allowance of £60 on first appointment. Free first-class passages and camp equipment. Liberal leave on full salary. Candidates, not over 40 years of age, must be fully qualified Engineers with experience in Railway Location.—Apply at once, by letter, stating age, and giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W., quoting at the top of application M/12,375. 4696

UNIVERSITY OF MANCHESTER
(FACULTY OF TECHNOLOGY).

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY.

APPOINTMENT OF PROFESSOR OF TEXTILE TECHNOLOGY

The City Council and the University of Manchester jointly invite applications for the Professorship of Textile Technology in the University of Manchester and in the College of Technology.

Commencing salary: £900 per annum.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester. The last day for the receipt of applications is Friday, 29th February, 1924.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

B. MOUAT JONES, Dean of the Faculty.
Principal of the College. 4743

Batley Corporation Water-WORKS.
BROWNHILL RESERVOIR.

The Waterworks Committee are prepared to receive TENDERS for the CONSTRUCTION of an EMBANKMENT, &c., for the formation of a RESERVOIR, with ANCILLARY WORKS, in the valley of the River Holme, a few miles from the Holmfirth Station of the London, Midland and Scottish Railway. The work will consist of the Excavation and Re-filling of the Puddle Trench, Boring and Grouting of the Strata forming Foundations, Earthwork Embankment, Waste Weir and Watercourse, Discharge Tunnel, Valve Shaft and Houses, Weir, Aqueducts, and Pipe Lines of various diameters, including Valve, and other Wells, Meter Houses, &c., together with a row of Nine Cottages. Drawings can be seen, and copies of the specification, schedule and form of Tender may be obtained on and after Monday, the 21st day of January, 1924, at the offices of Messrs. G. H. Hill and Sons (Manchester), Civil Engineers, 40, Kennedy-street, Manchester, upon receipt of the sum of Five Guineas. This sum will, after the Corporation shall have come to a decision upon the Tenders, be returned to those parties who shall have sent in a bona fide Tender, shall not have withdrawn the same, and shall have returned the documents and drawings lent to them for the purpose of making up their Tender. A limited number of sets of the drawings (uncoloured) are available, and will be lent to persons tendering in priority of application on receipt of the sum of Three Guineas, which will not be returned. Sealed Tenders, endorsed "Tender for Brownhill Reservoir," and addressed to the "Chairman of the Waterworks Committee," must be forwarded to the Town Clerk, Town Hall, Batley, on or before the 19th day of February, 1924. The Committee do not bind themselves to accept the lowest or any Tender.

THOS. E. CRAIK, Town Clerk.

Town Hall, Batley, 17th January, 1924. 4705

County Borough of Stoke-on-TRENT.
CONSTRUCTIONAL STEELWORK.

TENDERS are INVITED for the SUPPLY of STEEL WORK for FOUNDATIONS in the Central Power House, and to Support Boiler-house Firing Floor therein; also for STEEL ASH and SOOT HOPPERS for WATER-TUBE BOILERS. The whole will form one contract.

Tender form and specification obtainable from Borough Electrical Engineer, St. Peter's Chambers, Stoke-on-Trent, on deposit of £2.

Tenders to be delivered by Noon, February 13th, 1924, to—

R. B. SHARPLEY, Town Clerk.

Town Hall, Stoke-on-Trent, 25th January, 1924. 4699

PUBLIC NOTICES

Bombay, Baroda, and Central INDIA RAILWAY CO.

The Directors are prepared to receive up to Noon on Friday, 15th February, TENDERS for the SUPPLY of

SPRING STEEL.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices: 91, Petty France, Westminster, S.W. 1. 23rd January, 1924. 4739

City of Norwich.
ELECTRICITY COMMITTEE.
TO STEEL CONSTRUCTION ENGINEERS.

TENDERS are INVITED for the STEEL CONSTRUCTIONAL WORK for the New Generating Station at Thorpe Marshes, Norwich.

Drawings may be seen and stipulations of contract, specification, bill of quantities, schedule of prices, and form of Tender obtained on application at my office, accompanied by a deposit of £10, which will be refunded upon receipt of a bona fide Tender and the return of the stipulations of contract, &c. &c.

Tenders, on the forms supplied, enclosed in sealed envelopes, endorsed "Steel Structure," and addressed to the Chairman of the Electricity Committee, must be delivered at my office not later than 10 a.m. on Tuesday, 12th February next.

The Corporation does not bind itself to accept the lowest or any Tender.

ARTHUR E. COLLINS, M. Inst. C.E., Chartered Civil Engineer, City Engineer, &c.

Guildhall, Norwich, 21st January, 1924. 4725

TO ENGINEERS AND CONTRACTORS.

Cromer Waterworks.

The Cromer Urban District Council are prepared to receive TENDERS (from persons or firms who have had experience of works of a similar character) for the MANUFACTURE, ERECTION and SETTING to WORK of PUMPING MACHINERY and BOILER at the Pumping Station, Metton, near Cromer.

Plans can be inspected and specification and form of Tender obtained at the office of the Engineers, Messrs. J. C. Mellins and Co., 150, Gresham House, Old Broad-street, London, E.C. 2, on payment of Five Pounds, which will be returned on receipt of a bona fide Tender.

Sealed Tenders (in the prescribed form) are to be delivered, or sent to me, at or before Noon on Saturday, the 16th February, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

By order, J. K. FROST, Clerk to the Council.

Council Offices, Cromer. 18th January, 1924. 4736

Saint Ives (Hunts) Union.

The Guardians of the above Union invite TENDERS (with particulars of Plant) for the SUPPLY of a WATER SOFTENING APPARATUS at alternative prices, for dealing with 100, 150, and 200 gallons an hour.

The water to be softened is the East Hunts. Water Co.'s water.

Tenders, so marked, must be received by me not later than Saturday, the 9th February next.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order, GEORGE DENNIS DAY, Clerk to Guardians.

The Broadway, Saint Ives, Hunts. 22nd January, 1924. 4723

PUBLIC NOTICES

Egyptian State Railways.

TENDERS are REQUIRED for the CONSTRUCTION of STEEL ROOFS and SHELTER of Alexandria New Station.

Copies of the specification and drawings may be obtained from the Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, Broadway, Westminster, S.W., on payment of £4 8s.

Tenders are to be submitted to the AUTHORITIES IN CAIRO not later than the 1st May, 1924. 4676

Norwich Corporation.
THORPE POWER STATION.

The Norwich Corporation invite TENDERS for the MANUFACTURE, DELIVERY, and ERECTION of the undermentioned ENGINEERING WORKS, in connection with the Thorpe Power Station, viz.:

(f) Two 24in. and One 3in. Electrically Driven Centrifugal Pumps.

(g) Extra High-pressure Remote Controlled Main Switchgear, Extra High-pressure Hand-operated Auxiliary Switchgear, Low-pressure Hand-operated Auxiliary Switchgear, Cable Connections, &c.

(h) Overhead Mono-rail Telpher Coal Conveying Plant.

(i) Four Steel (alternatively Cast Iron) Tube Fuel Economisers, Two Steel Chimneys, Four Electrically Driven Suction Draught Fans, &c.

Specifications, drawings and forms of Tender may be obtained from Messrs. Preece, Cardew and Rider, 8, Queen Anne's-gate, Westminster, S.W. 1, on payment of a deposit of £2 for each section (issued in duplicate), which will be refunded on receipt of a bona fide Tender within the prescribed time.

Extra copies of either specification may be obtained on payment of Ten Shillings for each copy, which will not be returnable.

Sealed Tenders, endorsed "Thorpe Power Station, Tender for ——," must be delivered to me at my office not later than 10 a.m. on Tuesday, the 26th February, 1924.

The lowest or any Tender will not necessarily be accepted, and the Corporation will not consider any Tender which is incomplete, or which does not include the whole of the work covered by the specification for any section.

ARNOLD H. MILLER, Town Clerk.

Guildhall, Norwich. 19th January, 1924 4713

Tyne Improvement Commission.
DREDGER FOR SALE.

The Tyne Improvement Commissioners invite TENDERS for the PURCHASE, as it lies, exclusive of mooring chains and ropes, of No. 6 IRON-BUILT DOUBLE-LADDER BUCKET DREDGER, at present lying at moorings in the river at Jarrow. Length, 156ft.; breadth, 29ft.; depth, 12ft.; draught forward, 9ft. 6in.; draught aft, 8ft. 6in.; fitted with complete chain of buckets, 36 on each ladder, having a capacity of about 15 cubic feet per bucket, and capable of dredging to a depth of about 44ft. through independent friction gear port and starboard, driven by a set of side lever engines, with variable expansion gear.

The vessel may be inspected on application to the Manager at the Commissioners' Yard, Howdon-on-Tyne.

Full particulars and conditions of sale can be had on application to the undersigned.

Tenders, in sealed envelopes, endorsed on the cover "Tender for No. 6 Dredger," must be addressed to the Chairman, Dredging and River Works Committee, and delivered at the undermentioned offices not later than Noon on Friday, the 8th day of February, 1924.

The Commissioners do not bind themselves to accept the highest or any Tender.

By Order, ALBERT BLACKLOCK, Secretary.

Tyne Improvement Commission Offices, Bewick-street, Newcastle-upon-Tyne. 21st January, 1924. 4700

PUBLIC NOTICES

Southborough Urban District COUNCIL.
WATERWORKS.

The Southborough Urban District Council invite TENDERS from Contractors experienced in Well and Heading Work, for DRIVING 100 Yards of HEADINGS, more or less, at their existing Waterworks at Upper Hayesden, near Tonbridge, whilst the supply to the district is being maintained.

A plan of the work may be seen at the waterworks or at the office of the Engineers, Messrs. G. and F. W. Hodson, M.Inst.C.E., Loughborough and London, and copy of the particulars may be obtained from them on deposit of cheque for £5 5s., which will be refunded to bona fide tenderers on return of the documents.

Sealed Tenders, endorsed "Tender for Waterworks Headings, &c.," are to be addressed to the undersigned, and delivered at the Council Offices, Southborough, on or before Monday, 4th February, 1924.

The Council do not bind themselves to accept the lowest or any Tender.

Dated 16th day of January, 1924.

W. N. WOOD, Clerk to the Council.

Council Offices, Southborough, Kent. 4681

The Ministry of Public Works, EGYPT, is calling for TENDERS for the SUPPLY and ERECTION of a PUMPING PLANT at Boseili.

The contract will include the supply, delivery and erection of the whole of the Machinery and Accessories, including 4 Internal Combustion Engines each directly coupled to Centrifugal or Turbine Pumps.

Forms of Tender and specification, price 10s., can be obtained at the office of the INSPECTING ENGINEER, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1.

Tenders must be sent direct to Cairo, to reach there not later than Noon on the 31st March, 1924. 4657

Tyne Improvement Commission,
EXTENSION OF No. 3a COAL SHIPPING STAITH, WHITEHILL POINT, NORTH SHIELDS.

The Tyne Improvement Commissioners are prepared to receive TENDERS for an EXTENSION (of Steel Construction) of their No. 3a COAL SHIPPING STAITH, Whitehill Point, North Shields.

Copies of the form of Tender, conditions of contract, specification, and drawings may be obtained on application to the undersigned on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders must be sent to the undermentioned offices under cover, addressed to "The Chairman, Docks Committee," and endorsed "Tender for Extension of Coal Shipping Staith," not later than Noon on Thursday, the 31st day of January, 1924.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order, ALBERT BLACKLOCK, Secretary.

Tyne Improvement Commission Offices, Bewick-street, Newcastle-upon-Tyne. 18th January, 1924. 4701

Ormskirk Union.

FOR SALE, ONE STEAM ELECTRICITY GENERATING SET, 220 volts, 136 Amperes; Willans Engine; Two-crank Compound; Steam Separator, and One Spare Armature.

Engine may be inspected and further particulars obtained on application to the Master of the Poor Law Institution, Ormskirk.

Sealed Tenders, which must provide for the complete dismantling and removal of the engine, to be forwarded to the undersigned not later than the 11th February, 1924.

ALFRED DICKINSON, Clerk to the Guardians.

Ormskirk. 18th January, 1924. 4718

Tees Valley Water Board.

The above Board invite APPLICATIONS for the POSITION of MANAGER to the BOARD.

The candidate appointed will be required to devote the whole of his time to the duties of the office, and must have had experience in a similar position.

Applications, giving particulars of previous experience and stating salary required, accompanied by three recent testimonials, and endorsed "Manager," should be sent to the undersigned not later than Noon on Thursday, February 14th next.

Canvassing in any form whatever will be considered a disqualification.

R. BAINBRIDGE, Chairman to the Board.

Municipal Buildings, Middlesbrough. 4724

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.

SITUATIONS WANTED, Page 2.

PATENTS, Page 2.

PARTNERSHIPS, Page 2.

MACHINERY, &c., WANTED Page 2.

FOR SALE, Pages 2, 3 and 98.

AUCTIONS, Page 98.

PREMISES TO LET OR WANTED Page 3.

WORK WANTED, Page 4.

AGENCIES, Page 2.

MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 97, Col 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 97.

PUBLIC NOTICES

Singapore, Straits Settlements.
WATER DEPARTMENT.
ASSISTANT ENGINEER.

The Municipal Commissioners of Singapore REQUIRE an ASSISTANT ENGINEER, age 25-30, preferably unmarried, on a three years' agreement, with possible extension. He must have had a good technical education, a regular training as a civil engineer, and have a practical knowledge of Surveying, Levelling and Estimating, and at least three years' experience in works of Water Supply. Preference will be given to an Assistant who has passed the examination of the Institution of Civil Engineers as Assoc. M. Inst. C.E. The Testamur by examination of the Institution of Municipal and County Engineers will be an advantage. Salary 6060 dollars for the first, 7440 dollars for the second, and 7920 dollars for the third year, paid monthly, in dollars, the currency of the Colony, the value of the dollar being two shillings and fourpence sterling. The pay of the appointment for the first year at this rate would be £813. Such local transport allowance as may from time to time be sanctioned by the Commissioners will be paid. Free passage will be provided, with half-pay during the voyage out. The selected candidate must pass a medical examination.—Applications, stating whether married or single, age and place of birth, and giving details of education, training and experience, particularly in Waterworks, and referring to all the above requirements in detail, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. C. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents for the Commissioners (who will give further particulars if requested), not later than Tuesday, 5th February, 1924. 4716

South Indian Railway.

APPLICATIONS are INVITED from duly qualified candidates for VACANCIES for TWO ASSISTANT LOCOMOTIVE and CARRIAGE SUPERINTENDENTS on the Company's staff in India.

Candidates, who should not be less than 25 years of age and preferably unmarried, must have received a sound general and technical education, with subsequent training in Railway Locomotive or Locomotive Manufacturer's Workshops. They must also have had Locomotive Running Shed and Firing Experience.

The terms of appointments are an agreement for three years in the first instance, commencing on a salary of 450 Rupees per mensem, including an overseas allowance of 150 Rupees per mensem, rising by annual increments of 50 Rupees per mensem for each year of approved service to a maximum of 800 Rupees in the eighth year.

The Company will provide a first-class passage to India and the salary will commence from the date of sailing.

The forms upon which applications must be made will be forwarded upon application in writing being made to Messrs. Robert White and Partners, 2, Victoria-street, London, S.W. 1, the Consulting Engineers to the Company, who will at the same time forward particulars of leave, gratuity and Provident Fund rules.

W. B. REYNOLDS,
For Managing Director, South Indian Railway Company.

91, Petty France,
Westminster, S.W. 1. 4683

SITUATIONS OPEN

WANTED, ASSISTANT ENGINEER for New Lock Works; experienced in Deep Foundation and Mass Concrete Work; able to Prepare Contract Drawings and Specification under superintendence of Chief Engineer, and to act as Resident Engineer during construction. Application should state experience, salary required, with copies of three recent testimonials.—Address, 4707, The Engineer Office. 4707 A

WANTED in Railway Engineer's Office, London, ASSISTANT with experience in Permanent Way Details and Lay-outs, and able to Survey for same.—Address, giving full particulars of experience, &c., 4708, The Engineer Office. 4708 A

WORKS MANAGER REQUIRED for Works near London; must have full knowledge of High-speed Petrol and Paraffin Engines. State age, experience and salary.—Address, 4717, The Engineer Office. 4717 A

APPLICATIONS are INVITED for POST CHIEF LOCOMOTIVE ENGINEER on Colonial Railway in Africa. Salary £1500 per annum. Four years' agreement; free first-class passage. Applicants should state age, qualifications, past experience, and present occupation, and should furnish copies testimonials.—Write to Box 963, Leathwait and Sinamons, 34, Throgmorton-street, E.C. 2. P8566 A

ASSISTANT ENGINEER, Preferably with Experience on London Tubes.—Address, 4737, The Engineer Office. 4737 A

ASSISTANT ENGINEER REQUIRED by Westminster firm for Conveyor Work and Telpher Work, to supervise design and be responsible for complete contracts. Practical man with first-class experience only need apply.—Address, P8564, The Engineer Office. P8564 A

ASSISTANT WORKS MANAGER, with Good Organising Ability, mechanical knowledge and previous managerial experience, REQUIRED by large firm of Rolling Stock Engineers; all-round knowledge of Steel and Wood Construction necessary. Good salary to right man.—Address, 4632, The Engineer Office. 4632 A

ENGINEERS' TRAVELLER WANTED for London and South Coast. State experience and salary required.—E.921, c.o. Deacon's, Leadenhall-street, E.C. 3. 4695 A

FOUNDRY MANAGER REQUIRED for Iron and Steel Foundry; must have had a thorough practical training and be a good disciplinarian; up-to-date knowledge of Moulding Machines and expert experience on Cupola Practice and Mixing by Analysis. A knowledge of Semi-steel, also Electric Steel Furnaces, desirable.—Address, in confidence, stating experience, references and wages required, 4730, The Engineer Office. 4730 A

FUEL SUPERVISOR WANTED for Factory. Experience with Stirlings and Lancashires; knowledge of Heat Balances and Theory of Combustion essential. State salary.—Box 1034, Morison's Advertising Agency, Hull. 4722 A

IMPORTANT COMPANY REQUIRES REPRESENTATIVE, preferably an Engineer, with connection among shipbuilders and marine consulting engineers, to introduce Non-ferrous Alloys in all forms. Consideration given only to those having an established connection and able to introduce business.—Write, "H. W." c.o. J. W. Vickers and Co., Ltd., 5, Nicholas lane, E.C. 4. 4694 A

JAPAN AND BRITISH INDIA.—APPLICATIONS are INVITED for POSITION of REPRESENTATIVE in Japan and British India respectively, for large High-grade Steel Works. Applicants must have good technical knowledge of High-speed and Tool Steels, and good business experience; must also be personally acquainted with local conditions.—Write, giving full particulars of experience, &c., 4680, The Engineer Office. 4680 A

DRAUGHTSMAN, Experienced Designer, WANTED for Semi-direct By-product Plants for Coke Ovens; must be first-class man to Take Charge of Section.—Apply by letter only to ARTHUR DUCKHAM and CO. (1920), Ltd., 52, Grosvenor-gardens, London, S.W. 1, stating age, experience, references and salary required. 4727 A

DRAUGHTSMAN, Experienced in Design of Boring Machinery for Water and Oil Wells.—Address, giving details of experience and salary required, 4711, The Engineer Office. 4711 A

DRAUGHTSMAN REQUIRED. Must have had experience with Constructional Steel Firm in Steelwork for Buildings.—Apply, H. YOUNG and CO., Ltd., Thornycroft House, Smith-square, S.W. 1. 4726 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED IMMEDIATELY, with Shipbuilding and Shop Experience, for Design of Davits and other Boat Gear.—Full particulars to BARBER, Portland House, Basinghall-street, E.C. P8581 A

DRAUGHTSMAN WANTED, Experienced in Machine Tool Design and Jig and Tool Work.—Address, stating age, experience and salary required, 4738, The Engineer Office. 4738 A

DRAUGHTSMAN WANTED. Must Have Good general training with experience in the Design of Heavy Machinery, for works near Manchester. In applying state experience, age and salary expected.—Address, P8580, The Engineer Office. P8580 A

DRAUGHTSMAN WANTED in London, Experienced in Design of Conveyors and Elevators.—Write, stating age and salary required, to F. H., c.o. J. W. Vickers and Co., Ltd., 5, Nicholas lane, E.C. 4. 4748 A

DRAUGHTSMAN, with Experience in the Design and Lay-out of Woodworking Machinery, REQUIRED by large firm of Engineers, Manchester district. Applicants should give full particulars of training and experience, also age and wages required.—Address, 4746, The Engineer Office. 4746 A

DRAUGHTSMEN (SENIORS). First-class Men only, for Switchgear, REQUIRED by London firm. Good money for right men.—Address, 4640, The Engineer Office. 4640 A

DRAUGHTSMEN.—THE BRITISH THOMSON-HOUSTON CO., Neasden-lane, Willesden, N.W.10, INVITE APPLICATIONS from first-class SWITCHGEAR DRAUGHTSMEN.—Write, stating age, salary and experience, to CHIEF DRAUGHTSMAN. 4641 A

DRAUGHTSMEN WANTED by London Firm, with first-class experience in the Design and Lay-out of up-to-date Switchgear. Good salary for really capable men.—Write, stating age, experience and salary required, 4639, The Engineer Office. 4639 A

ELECTRICAL ENGINEER - DRAUGHTSMEN WANTED by Firm in N.W. London for the Preparation of Connection Diagrams for Power Station Switchgear. First-class men with good technical training only need apply.—Write, stating age, experience and salary required, 4638, The Engineer Office. 4638 A

FIRST-CLASS STRUCTURAL DRAUGHTSMEN REQUIRED; none but experienced men need apply. State full particulars, age, salary required.—THE CLEVELAND BRIDGE and ENGINEERING CO., Ltd., Darlington. 4453 A

FIRST-CLASS DRAUGHTSMAN REQUIRED by London Conveyor Co. in their Project Department. Give fullest details of experience. Strictest confidence guaranteed.—Address, P8565, The Engineer Office. P8565 A

JUNIOR DRAUGHTSMAN REQUIRED. Neat Tracer and able to Prepare Small Pencil Drawings from models or sketches; progressive position for intelligent applicant.—Address, stating age, salary and experience, P8567, The Engineer Office. P8567 A

WANTED, a Competent FOREMAN to Take Charge under the Engineer of Heavy Concrete and Reinforced Concrete Work, including Underwater Foundations. Also an experienced CONCRETE CARPENTER for False Works, Mould Boxes, &c., therefor.—Address, stating experience, age, wages required, 4706, The Engineer Office. Originals of testimonials, &c., not to be sent. Work expected to last a year. 4706 A

SITUATIONS WANTED

WANTED, a POSITION as Works Manager, Chief Rate Fixer or Production Engineer; thoroughly conversant with present-day methods and requirements; rate-fixing, planning and factory organisation; accustomed to control labour, tactful, energetic; excellent credentials.—Address, P8592, The Engineer Office. P8592 B

C.E. (27), B.Sc., SEEKS POSITION on Constructional work, home or abroad; 3 years' waterworks experience; competent surveyor and draughtsman.—Address, P8571, The Engineer Office. P8571 B

COMBUSTION ENGINEER SEEKS SITUATION; 12 years' experience boiler plant efficiency; best references.—Address, P8585, The Engineer Office. P8585 B

CONSTRUCTIONAL ENGINEER DESIRES POSITION OF TRUST, England or abroad; experienced in factory, steelwork and aerial ropeway erection. Hard worker; fluent Spanish; excellent references.—Address, P8568, The Engineer Office. P8568 B

CONTRACTORS' AGENT, with 16 Years' Experience in responsible charge large dock and public works contracts, OPEN RE-ENGAGEMENT.—Address, P8591, The Engineer Office. P8591 B

ECONOMICAL INDUSTRIAL REORGANISATION.—Reliable experienced ENGINEER AVAILABLE for ENGAGEMENT.—Address, P8569, The Engineer Office. P8569 B

ENGINEER, M.C., B.Sc. (1st Hons., London), A.M.I.C.E., M.I.E.E., 15 years' experience with A.C. and D.C. plant, electric vehicles and traction, steam plant, crushing, screening and conveying plants, furnace and structural work, refuse utilisation and disposal problems, factory organisation and management, REQUIRES APPOINTMENT with prospects, home or abroad.—G. W. S., Cheyne Lodge, Thames Ditton, Surrey. P8578 B

ENGINEER (24), A.M.I.C.E. exam., 5 Years' Pupil, Locomotive, millwright, &c., D.O. experience, SEEKS POST under Civil or Mechanical Engineer at home or abroad; knowledge of French and Spanish.—Address, P8575, The Engineer Office. P8575 B

ENGINEER (27), Public School, University, Technically trained, ex-sapper officer, DESIRES WORK at home or abroad; 11 years with large engineering concern, 4 years drawing-office, jigs, fixtures, machine and special tools, oil and textile plant, 5 years shops, 1 year French agent, 1 year representative; Aug., 1914 to 1920, Royal Engineers; 1 year as instructor; 1920 to present date on own patent experimental work.—Address, P8583, The Engineer Office. P8583 B

ENGINEER, Age 35, 16 Years' Experience in managing and maintaining power-house, hydraulic plant, I.C. engines, SEEKS POST with responsibility; excellent refs.—Address, P8547, The Engineer Office. P8547 B

ENGINEER (29) DESIRES APPOINTMENT, Home or abroad; first-class B.O.T. cert., well versed in workshop practice and general knowledge; excellent references; would consider Partnership; single.—Address, P8586, The Engineer Office. P8586 B

ENGINEER (40), with Managerial Experience of works organisation and production, wide technical knowledge, control of staff, buying, preparation of estimates, inspections, plant maintenance, for power plants, motor vehicles, railway material, ship fittings, general engineering, DESIRES POST or REPRESENT FIRM with above material at Wembley.—Address, P8582, The Engineer Office. P8582 B

ENGINEER (43), A.M.I.C.E., M.I.M.E., with Long experience in mining, railway, dock and contractors' plant and machinery, DESIRES POSITION as London Representative or Agent.—Address, P8511, The Engineer Office. P8511 B

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

Dutch Shipbuilding.

THE placing of the order for the Nederland Steamship Company's new motor passenger liner with the Ateliers et Chantiers de la Loire at St. Nazaire reveals in a striking manner the difficulties under which shipbuilding and engineering concerns in Holland are working. According to the published figures the subsidised price quoted by the French firm was in the neighbourhood of 25 per cent. below that quoted by Dutch firms. Every effort was made to keep the work in Holland, but even after the home builders had been given an opportunity to reconsider their prices, it was not found possible, even by facing considerable loss, to reduce the cost of building to within 15 per cent. of the French offer. The lowest British tender was that of Workman, Clark and Company, Ltd., of Belfast. To those in close touch with industrial conditions in Holland, the position is not perhaps so surprising, for there is but a small margin between the cost of material—practically all of which must be imported—and the price of the ship. Again, in this small margin full account must be taken of the reduced hours worked and the higher wages paid. For some time after the war only forty-five hours per week were worked in Holland, and after appeal was made, the working week was increased to forty-eight hours, with special overtime permits in case of long-continued ship repairs. The instance we have spoken of clearly illustrates the abnormal conditions obtaining in Dutch shipbuilding and the increased competition of the French yards.

Paris a Seaport.

OF all the measures that have been proposed to protect Paris from floods it seems to have been definitely decided that the only one which is to be put in hand for the time being is the deepening of the Seine. The Minister of Public Works has declared that, with the resources already available, it will be possible to carry out the work and complete it within a period of fifteen years. The depth of the river will be increased from the 3.50 m. originally proposed to 5 m., so that sea-going vessels drawing 4.50 m. of water and carrying cargoes of 2000 and 2500 tons will be able to reach Paris, where ample dock accommodation will be provided. The cost is estimated to be about 800 million francs, which, it is hoped, will be partly raised by the Chambers of Commerce and other bodies interested in the undertaking. At the same time five barrages will be reconstructed to provide a head of water of 4 m. for supplying energy to works and factories in the neighbourhood. It is true that doubts have been expressed as to whether this head would be maintained in summer, but the Minister of Public Works is perfectly confident that the scheme will prove satisfactory, both financially and commercially.

Somerset Oil Shales.

SOME particulars of the great oil shale beds recently discovered in West Somerset were given at a meeting in Bridgewater last week by Dr. W. Forbes Leslie. These beds, which stretch along the coast of the Bristol Channel from Watchet on the west to Combwich on the east, are said to be the most extensive ever discovered in the world. The total vertical thickness is put at 1000ft., and throughout this depth there are alternate seams of oil shale and lias limestone. The shale seams vary in thickness from 2ft. to 25ft., while the area is some 10 square miles. Geologists have estimated that there must be 9,000,000,000 tons of workable shale, a large part of which is above water level, as the deposits form coastal cliffs up to 120ft. high. The result is that it will be possible to quarry the shale very economically, and it is hoped that the cost will not be above 3s. a ton. The average oil content is expected to be 40 gallons per ton, so that the beds should be capable of yielding 360,000 million gallons of oil. It is proposed not only to win the oil, but also to use the limestone and by-products of the distillery in the manufacture of cement.

Continuous Brakes for Goods Trains.

THE selection of a definite type of continuous brake for goods trains on the Continent has not yet been finally made, despite the efforts of the French Government to impose the Westinghouse brake in preference to the German brake, which is being employed so extensively in some countries as to suggest the possibility of its securing a monopoly before the Berne Conference can come to a decision. Nor is it expected that a settlement will be arrived at by the Conference which is to be held at Florence at the end of this month. As a matter of fact, while France has gone in solid for the Westinghouse brake, other countries are not disposed to accept the French trials as conclusive, and are carrying out experiments with various compressed-air systems. Even in Switzerland trials are being made with the Drolshammer compressed air brake, which is also to be experimented with in Italy and Austria. Meanwhile, some of the French railway companies have given out orders for trucks equipped with the Westinghouse continuous brake, and as it appears fairly certain that France will not give way, arrangements are already being made for the manufacture of these brakes for the equipment of the whole of the goods wagons, numbering about 250,000, at a cost of something like 300 million francs. One reason for the French advocacy of the Westinghouse continuous brake is that it is no longer covered by patents, except so far as concerns the valve mechanism. A group is, therefore, being formed, including all the makers of brakes, to cope with this huge business when it is given out. Now that different countries are working out the problem in their own way, conflicting interests can only be conciliated by rendering the various systems interchangeable, which is provided for in the report presented by the French Brake Commission.

The Supply of Electricity to Railways.

SPEAKING at a recent meeting of the Institution of Electrical Engineers, Mr. H. N. Gresley dealt with the question of purchasing current from public supply companies for working railways. It would be unwise, he thought, for a railway company to tie itself to a supply company for indefinite number of years. Improved methods of generation might considerably reduce the cost of producing the current, and a railway that entered into an agreement to take current from a supply company for a number of years would not reap the benefit of those improvements. He doubted if the railways would ever be able to buy current more cheaply than they could generate themselves, for they could raise capital cheaply, and they had many hotels and other premises to supply. Speaking later in the discussion, however, Mr. G. W. Partridge, of the London Electric Supply Corporation, explained that contracts with railway companies contained clauses for the revision of prices at stated intervals, and railway directors and managers could rest assured that they would reap the benefit of any improvement that might be made in the generation of electricity if they were prepared to pay a reasonable amount of interest on the capital expended. From what we hear, too, Mr. Gresley's doubts as to railway companies not being able to buy current more cheaply than they could make it, are falsified by the experience of what was originally the Old Lancashire and Yorkshire Railway.

French and Italian Submarines.

AN important modification is announced in the second half of the French naval programme, as the result of an agreement between the Government and the Naval Commission of the Chamber of Deputies. Under the original scheme a certain number of ships were to be built in the period ending in 1930, but it is now decreed that all the vessels in question shall be laid down between 1924 and 1928, for completion not later than 1931. No change has been made in the number or types of surface ships provided for, viz., six cruisers of 10,000 tons, 15 flotilla leaders of 2400 tons, and 24 destroyers of 1200 tons. On the other hand, two of the four 3000-ton "sousmarins de croisière" have been dropped from the programme, as it is now deemed inexpedient to build more than two vessels of this experimental type until the design has been subjected to practical test. In place of the two submarine cruisers cancelled, seven mine-laying submarines of 770 tons are to be ordered, while the construction of 30 torpedo-carrying submarines, of 1400 tons, authorised in the original scheme, is to be proceeded with. Including boats already laid down under the initial section of the programme, the following submarines are now being built or have been projected for the French Navy: two of 3000 tons, 36 of 1130–1400 tons, 19 of 600–770 tons—a total of 57 boats. All these vessels, including the minelayers, are to be armed with the new 21.7in. torpedo. The majority will have Schneider-Carels Diesel engines for surface propulsion. It is announced from Rome that a contract has been placed with the Cantiere Ansaldo-San Giorgio, at Spezia, for the construction of four submarines authorised in the current Italian programme. They will have a surface displacement of more than 1000 tons, and be propelled by Ansaldo or Tosi Diesel engines.

South African Railways.

THE report of Sir William Hay on the railways of South Africa during the year ended March 31st last, shows an increase of 0.25 per cent. in the number of passengers and of 3.27 per cent. in tonnage. The revenue owing, for the most part, to reductions in rates and fares, fell 3.17 per cent. The ratio of working expenditure to earnings was 77.1 per cent. as against 82.7 per cent. in 1921–22, 79 per cent. in 1920–21, 78.9 per cent. in 1919–20, and 75.6 per cent. in 1917–18. Since the close of the financial year there has, however, been a marked improvement in the position. For the period from April 1st to August 31st the earnings rose 7.3 per cent., but with an increase of only 2.9 per cent. in expenditure. Goods traffic was exceedingly heavy; in fact, the last week of this period brought in the highest record for goods earnings. Rates were increased in 1918 and 1920 to meet the higher cost of wages and the increased prices of materials. Reductions have since been made as opportunity offered, but, generally, the tariffs are still higher than they were. The report adds: "Notwithstanding this, however, the administration is to-day in receipt of a lower revenue per ton-mile than that derived during the pre-(South African) war period, owing to the greatly increased preponderance of low-rated over high-rated traffic." This preponderance is caused by the fact that in former years high-rated imported traffic was carried inland and the trucks came back empty. Now the trucks come from inland to the ports laden with low-rated export traffic in coal, grain, &c., and the high-rated import traffic has decreased. We give prominence to the above figures, as they appear to confirm the statement made in our leading article on State Railways on October 5th. It was said then that the South African railways "set an example to all the State-owned systems in the world, and to the majority of those company-owned. The cause of this excellence does not, however, lie in the fact that South African railways are Government-owned, but in the ability of those who administer them, and in the confidence shown by Governments, traders, and the public in those at the head of railway affairs."

Greek Destroyer Repairs for Cowes.

IT is announced that four Greek destroyers, the Aetos, Jerax, Leon and Panther, are now on their way to Cowes, where they are to be re-boilered and reconditioned by J. Samuel White and Co., Limited. These 980-ton ships were built by Cammell Laird and Co., Limited, and, with turbine machinery of 19,750 shaft horse-power, are designed for a speed of 32 knots. Originally intended for the Argentine Navy, the vessels were launched on the Mersey in 1911, and were purchased by Greece in the October of 1912. The present contract for refitting includes, we understand, new boilers and boiler-room auxiliaries, and complete overhauling of the turbine machinery. At present the destroyers are arranged for both coal and oil burning, but they are now to be converted for oil burning only, and the coal bunkers will be replaced by oil fuel tanks. In addition to the alterations to the hull and the machinery repairs, new guns and firing controls are to be fitted. This work will form part of a contract with Vickers Limited. The repairing of these four destroyers is, we believe, the first foreign naval contract of its kind which has been placed in Britain since the war.

The American Airship Shenandoah.

ACCORDING to all accounts, the American airship Shenandoah, which broke away from her mooring mast in a violent gale last week, would seem little the worse for the trying experience she went through. At the time of the accident the dirigible had been moored at the mast for nearly four days. When the storm developed suddenly, the metal nose cap was torn from the outer sheath of the hull and the airship drifted away in the gale. Despite the wind and rain, an even keel was maintained, and the engines were kept running. After nearly eight hours the airship made her way to the hangar at Lakehurst, and was safely docked, after what must have been a remarkable display of skill on the part of her commander. The mooring mast does not appear to have been damaged.

The Railway Strike.

AT midnight on Sunday, January 20th, Mr. Bromley put into action his threat to bring out the members of the Associated Society of Locomotive Engineers and Firemen. He took that step, on the strength of a ballot of the members of his union, despite every effort made by the railway companies, short of absolute departure from the recommendations of the National Wages Board, to avert it. The companies, whilst adhering to those findings, expressed their willingness to consider any cases of exceptional hardship and promised that there should be no dismissals. But Mr. Bromley was not to be moved from his position, and the efforts of the companies, supported by the National Union of Railwaymen and the General Council of the Trades Union Congress, both of which expressed their strong disapproval of the action of the Associated Society, were unavailing, and, as we have said, the strike notices took effect from midnight on Sunday. The dislocation of the railway services is considerable, and the inconvenience to the public is great, but the men of the N.U.R. are in most cases loyal to their leaders and are remaining at work, so that fairly good services are being run. On Monday and Tuesday Mr. Bromley expressed his willingness to meet the companies again, but the companies naturally replied that unless he was prepared to accept the findings of the National Wages Board, further conferences would be futile.

The Turbines at Raanaasfoss Power Station, Norway.*

By HALLGRIM THORESEN, Consulting Engineer, Christiania.

No. II.†

Efficiency Tests of the Turbines: Testing Arrangements.

Stipulations were inserted in the contracts with both firms supplying the turbines as to how the tests should be carried out. The measurement of the volume of water was to be made by means of current meters at the sluice gates, where wooden mouthpieces

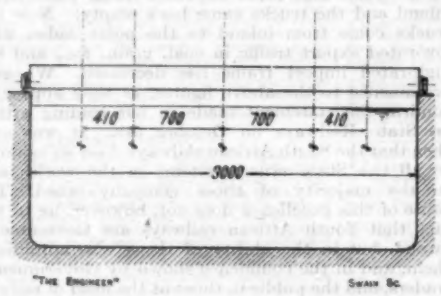


FIG. 10—ARRANGEMENT FOR CALIBRATING FLOW METERS

were to be built in. The upper water level had to be read off at four points in the flume above the turbine, and the lower water level at four points at the outlet

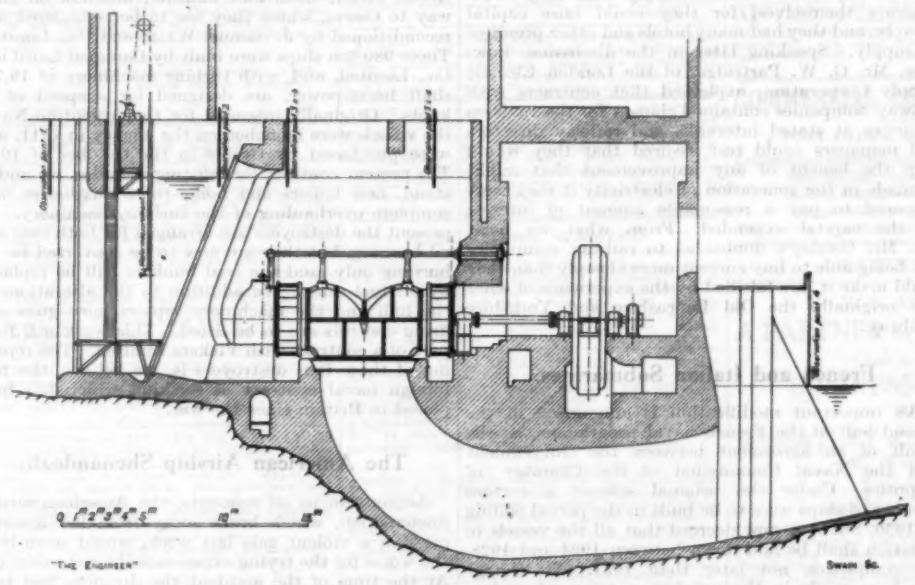


FIG. 11—SECTION THROUGH POWER HOUSE SHOWING POSITIONS OF OBSERVATION POINTS

of the discharge flume. The net head was to be the difference between the upper and lower levels thus obtained. The power had to be determined in the usual way by measuring the electric energy developed.

The measurement of such large volumes of water as were in question in this case presented many difficulties, especially since the measurements had to be made in a comparatively short time. The area of each gate opening in front of the turbine is about 540 square feet. Even if a reduction in this area had been made by building wooden mouthpieces for the purpose of measurement, an area of about 430 square feet would still have been left in each of the two openings in which the readings were to be taken. As measurements would have had to be taken with current meters at at least sixty to seventy points in each opening, and as the observation at each separate point might take 5 minutes, at least 5 hours would have been required for the measurement, if only one current meter were used in each opening.

It was, therefore, important that a method should be found whereby the measurements could be made in less time. Previously, in similar cases, measurements have been made simultaneously with two current meters in the same cross section, which naturally reduces, to some extent, the time required for the measurement. As the shape of the passage in which measurements had to be taken was, in this case, rectangular, it was natural to arrange the points of measurement along vertical lines, which lay symmetrically in relation to the side walls. Presuming that as many current meters could be introduced as there were vertical lines formed by the measurement points, observations could be made simultaneously at those points lying in one horizontal line in the area in which measurements were being taken. The current meter could be mounted on a frame which could be raised or lowered. Such an arrangement would, in the case under consideration, require fourteen current meters, and it was found possible to obtain that number.

The objection may be raised, however, to a simultaneous measurement with a number of current meters that one may so influence the other that the calibration factor found on testing one meter may not be valid when several are running alongside each other. In order to test this, five current meters were mounted side by side on the same carriage and placed over the 10ft. wide testing flume in the Water Power Laboratory at the Technical High School at Stockholm—see Fig. 10—and the calibration factors determined. A comparison of these factors with those found when testing each current meter by itself immediately beforehand, showed that in three of the five current meters the difference was less than 0.1 per cent., and in the other two the difference was 0.2 per cent. The difference, therefore, is not greater than could be accounted for by errors in observation.

The measurement of the water was, therefore, carried out in the following manner. At a height of 2 m. above the bottom of the sluice gates a plank floor was laid. It extended to the guide channels for the stop logs in one direction and to the fine screens in the other. The sluice gates were raised so that their bottom edges were exactly on a level with the concrete beam in front. Immediately behind the gates, and on a level with their bottom edges, a horizontal plank deck was built. This deck, together with the bottom edge of the gates and the concrete beam in front of the gates, formed the upper boundary of the measurement cross section. The sluice gate guide channels were filled in with wood, so that the side walls were smooth and parallel from the stop logs to the place of the measurement. The current meter measurements were made at the inner end of this run—see Fig. 11. Behind this place for measurement, guides were fixed to the walls of the turbine flume in which the frame carrying the current meters could be raised or lowered.

Fig. 12 shows the construction of the current meter frame and the distance between the meters whilst the measurements were being taken. On each of these frames seven meters were mounted, and so adjusted so that they lay in the same horizontal line. The frames could be raised up and fixed at levels suitable for measurement. The height of the measurement cross section was 29.4ft., and measurements were taken in it at ten different levels. The lowest line was about 4in. above the bottom, and the highest about 4in. under the top boundary. To allow of the frame with the current meters being lifted above the surface of the water, a slot for each single meter was cut in the top lining behind the gates. The electric contact wires from the current meters were run up along the frame to the observation places. As there were two measurement cross sections in front of each turbine, there were, in all, fourteen current meters in use during each measurement. In order to avoid too many observers, each one had two current meters under observation, and the wires were from these meters coupled so that by means of a switch those meters from which, for the moment, readings were not being taken could be cut out. The readings of at least 60 seconds duration were made one after the other at each point.

Immediately after the tests were made, all the current meters were sent to the Technical High School in Stockholm, and in the Water Power Laboratory there they were checked by the State Meteorological-Hydrographical Institute.

In order to determine the head the water levels were observed at five different points—see Figs. 11 and 13—namely:—

Point 1 was at the side of all intakes and consisted of a fixed measuring rod. On this rod the head water level of the power station is to be observed in practice. During the tests the water level was read off every 5 minutes.

Point 2 was, likewise, in front of the ice screens. Four measuring rods were set up here, one on each side of the two courses, and during the tests readings were taken every 4 minutes. The readings at point 1, as well as at point 2, are without bearing on the efficiency, but were taken in order to get a view of the head losses of the plant.

Point 3.—In each corner of the turbine flume a measuring rod was set up, and on these rods the level was read off each fourth minute during the tests. These readings were taken as decisive for the head race level for calculating the efficiency.

Point 4 was just at the discharge opening of the discharge flume, and the lower water level was measured at four points by means of a movable measuring rod. In addition, readings were taken at four points just outside the adjacent discharge flume, from which, at the time, no water was allowed to flow. The readings at these latter four points only served as a check on the readings at the first. In this case readings were taken every 8 minutes. It was found that the water level at Point 4 was somewhat lower than that further out in the tail race. This was due to draught tube discharge end being formed to regain the exit velocity. The shape of the discharge flume opening is based on the following consideration:—The total discharge area of the flumes will be less than the area of the tail race immediately outside the piers between the orifices of the discharge flumes. Beyond the piers the bottom slopes upward, so that the area is somewhat reduced. If the discharge velocity from the draught tube is examined, it will be found that the velocity is retarded at first by the water passing through the large area outside the piers and again accelerated when the water comes out into the actual tail race.

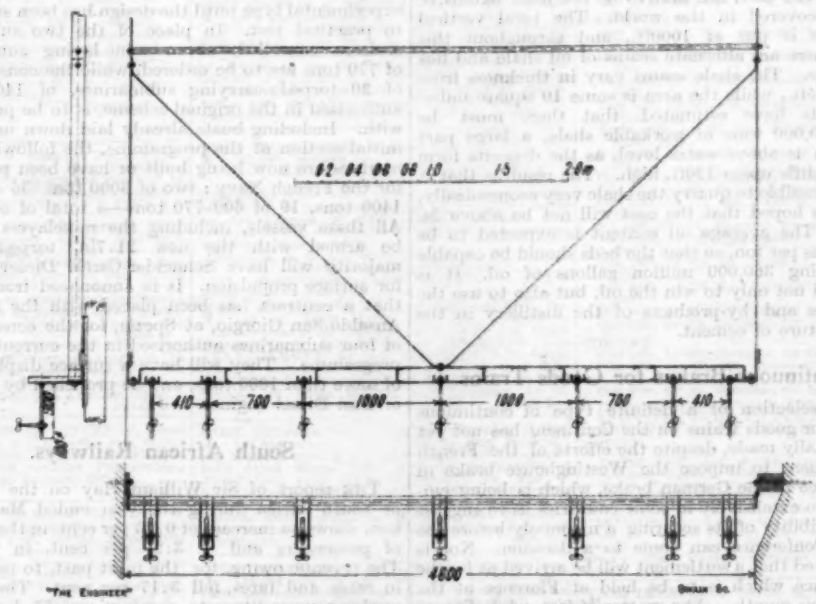


FIG. 12—ARRANGEMENT OF FRAME FOR FLOW METERS

* Being a part of the official account of the whole installation, prepared by the Akershus Elektricitetsverk.

† No. I. appeared January 18th.

To avoid this drop and rise in velocity, the piers are formed with noses of such shape that the velocity of the water is kept almost constant from the mouth of the draught tube until it reaches the tail race proper. The arrangement is shown in Figs. 11 and 13 and also in Figs. 14 and 15.

The lower water level, or Point 4, as compared

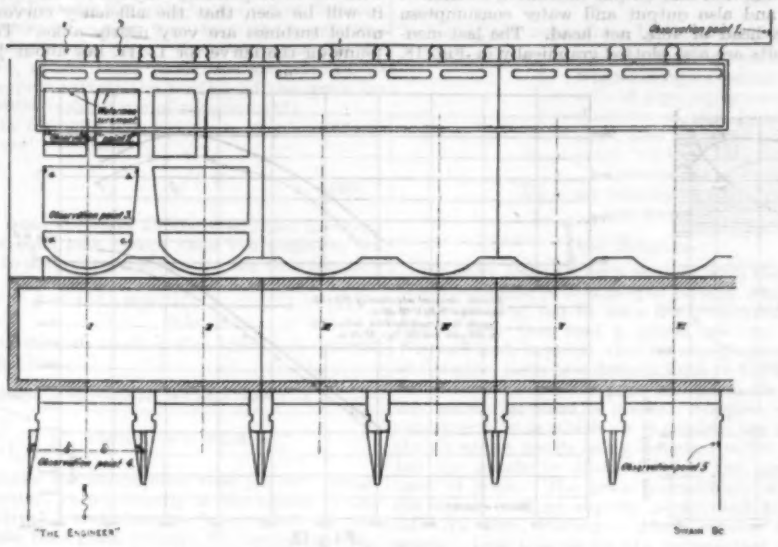


FIG. 13—PLAN SHOWING POSITIONS OF OBSERVATION POINTS

with points further out in the tail race shows that the shapes of the bottom and the piers answer their purpose. As the difference between the levels at Points 3 and 4 constitutes the net head, a lower level at point 4 will naturally correspond to a greater net head, or, in other words, the lower water level at point 4 may be said to be somewhat unfavourable to

five minutes while the test was being carried out, were of considerable interest for determination of the relation between the water level at the ordinary gauge for the tail water level of the power station and that immediately outside each draught tube. The difference between the readings at Points 1 and 5 is the head, which is read off daily at the power station, and may be taken as being the gross head under which the station is operating. It will be seen from the summary of the head conditions during the test that the gross head thus found is throughout a little less than the net head. This difference is due to the loss of head in the sluices and screens being less than the difference in levels at Points 4 and 5.

carry out the latter in about an hour and a-quarter. The calculation of the power developed by the turbine was based on the generator efficiency, which was ascertained by actual test, and was found to be about 1 per cent. above that guaranteed.

The speed of the turbine was read off on a tachometer in the generator room. This instrument was checked both before and after the tests. The guide vane opening and the vacuum gauge readings were also noted in the generator room. From the above it will be understood that the carrying out of the tests required a considerable staff. Sixteen observers, besides assistants, were required to make the readings. There were in all about twenty-five men employed during tests.

RESULTS OF TESTS MADE WITH TURBINE NO. I., DELIVERED BY VERKSTADEN, KRISTINEHAMN.

The tests were carried out from May 11th to 16th, 1922, and were undertaken by a commission consisting of Elov Englesson, chief designer of the Verkstaden Kristinehamn, and H. Thoresen, hydraulic engineer, Kristiania, with Professor G. Sundby, from Trondhjem, as referee. Water level observations, measurement of water and power were accurately carried out in accordance with the above description. During the period of test the head was about 39.5ft. For measuring the vane opening for test purposes the relation between the gate indicator readings and the actual opening of the guide vanes was determined beforehand.

In addition to the efficiency tests, tests were also made of the output at varying speeds.

In Table No. I. are given the mean values of all observations for water level, speed, vane opening and suction head recorded during the efficiency tests as well as the gross and net heads, measured water consumption, measured output and efficiency, and also the output and water consumption, based on a net head of 40ft. The results calculated to a net head of 40ft.—12.25 m.—are, moreover, shown in the graph—Fig. 16.

The relation between the guaranteed efficiency and that obtained with a 40ft. net head and

TABLE I.—*Results of Efficiency Tests on Turbine I., Raanaasfoss, May 15th, 1922.*

	Mean of water level observations.							Mean of observations in machine room.						Calculated to H = 12.25 m.		
Time.	Upper water level. 1	Water level front of screens. 2	Water level turbine pit. 3	Lower water level suction pipe. 4	Lower water level measuring rod. 5	Gross head 1 ÷ 5.	Net head 3 ÷ 4.	Vane opening.	Vacuum gauge.	Revs. per minute.	Shaft horse-power.	Measured water volume.	Efficiency.	Revs. per minute.	Horse-power.	Water volume.
	Metres.	Metres.	Metres.	Metres.	Metres.	Metres.	Metres.	Mm.	Metres.			Cubic m.	P.c.			
10.10–11.25	118.60	—	—	—	106.670	11.93	—	50	—	105	0	22.22	—	106.4	0	22.5
11.54–1.31	118.596	118.601	118.597	106.665	106.661	11.935	11.932	102.9	2.6	105	4,560	41.678	68.8	106.4	4,740	42.21
1.42–3.10	118.589	118.577	118.575	106.663	106.679	11.910	11.912	153	2.2	105	8,350	61.814	85.0	106.4	8,700	62.7
3.22–4.54	118.603	118.561	118.567	106.631	106.679	11.924	11.936	204	2.165	105.2	11,240	76.58	89.9	106.6	11,680	79.58
7.01–8.16	118.677	118.617	118.624	106.605	106.685	11.992	12.019	234.4	2.10	105.9	12,085	87.668	86.0	107	12,430	88.48
8.30–9.41	118.682	118.605	118.625	106.612	106.663	12.019	12.011	253	2.093	107.0	12,235	91.47	83.5	108	12,580	92.4

the turbine manufacturers. The measurement point, however, is clearly specified in the contract and the measurement was carried out accordingly.

Point 5 lies alongside all discharge openings and constitutes the usual point for the measurement of the tail race level of the power stations. While the tests were carried out there was no water being discharged

A water resistance of ample dimensions was built outside the power-house to absorb the energy developed during test. It was designed for the generator voltage of 7500 volts, and was connected by cables with one set of generator bus-bars. During the efficiency test the energy developed was measured by means of accurate instruments, readings being

107 revolutions per minute was as follows:—

Output in horse-power	4,800 ..	7,200 ..	9,000 ..	10,440 ..	12,000
Guaranteed efficiency, per cent.	67 ..	78 ..	84 ..	85 ..	80
Measured efficiency, per cent.	69.1 ..	80.1 ..	87.4 ..	89.1 ..	89.1

The maximum efficiency measured was 89.9 per

FIGS. 14 AND 15—DISCHARGE OUTLETS

from turbine No. VI., so that the water level at Point 5 can be looked upon as practically corresponding to the proper tail race level. As may be seen from the summary of the conditions relating to the head during the tests, the water level at Point 5 was throughout higher than at Point 4.

The observations at Point 5, which were made every

taken every five minutes during the whole period of the test. The output was exceptionally constant as the guide vane opening of the turbine could be kept absolutely constant by means of the load-limiting device on the governor.

The time required for the tests depended upon the water measurements, and it was found possible to

cent., at 11,650 horse-power. According to the curve the best efficiency is at 11,360 horse-power, and amounts to 90.1 per cent. The efficiency was thus considerably better than that guaranteed, and the Verkstaden obtained the premium stipulated in the contract for excess efficiency. The efficiency obtained is very high, especially for this type of turbine, for

which the discharge conditions are less favourable than with a vertical type.

The results are of great interest. They corroborate the excellent results which were obtained at the Untra power station.† Which showed that with double horizontal turbines efficiency curves may be obtained which are equal to those of vertical turbines.

It may be of interest to compare the above efficiency curves with those obtained with the model turbine, the dimensions of which in relation to those of the actual turbine were as 650 : 2950. In the consumption and output, were carried out exactly in accordance with the previously described rules. The head was about 42.6ft. In addition to efficiency tests, output trials at varying speeds were also carried out. Table No. II. contains mean values of all readings recorded for water levels, revolutions per minute, gate opening, vacuum gauge, gross and net head, water consumption and output measured, calculated efficiency, and also output and water consumption based on a head of 40ft. net head. The last-mentioned results are also plotted graphically in Fig. 18.

being different from those of the model runner. By a comparison of the diagrams for the two test results —Fig. 19—it will be gathered that the efficiency curve for the large turbine is displaced sideways without being raised with reference to the efficiency curve of the model runner.

When comparing the above-mentioned diagrams with the corresponding diagram for turbine I. to III., it will be seen that the efficiency curves for both model turbines are very nearly alike. The highest point on the curve for I.-III. lies about ¼ per cent.

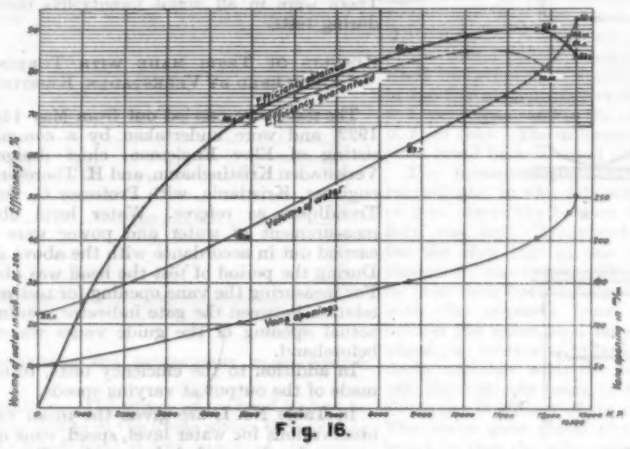


Fig. 16.

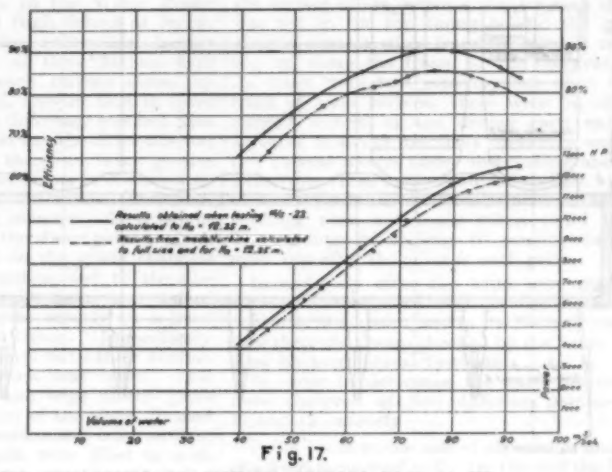


Fig. 17.

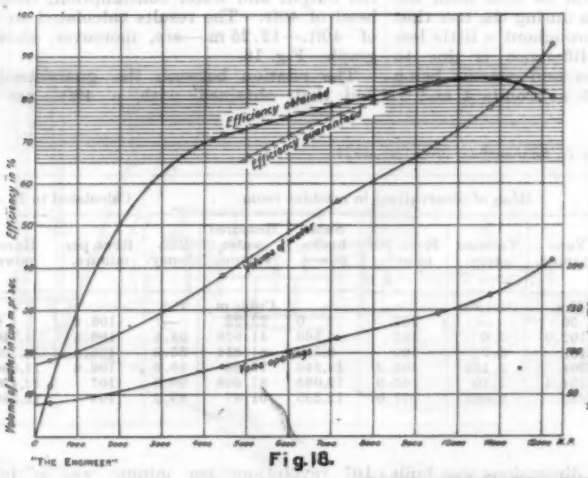


Fig. 18.

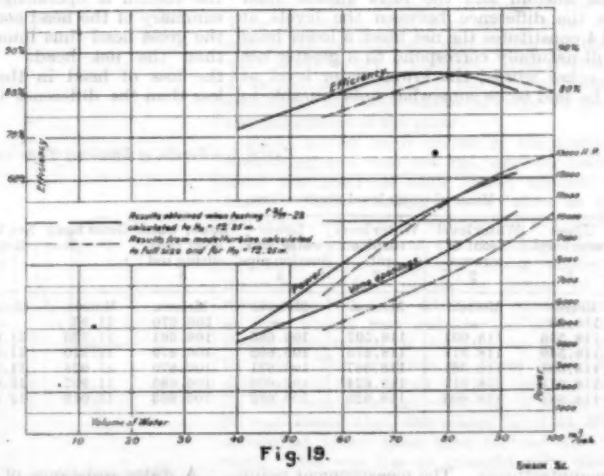


Fig. 19.

CURVES ILLUSTRATING THE RESULTS OF TESTS OF TURBINES

graph—Fig. 17—the results of the model turbine converted to the same dimensions as the actual turbine and a net head of 40ft., are shown. It will be noted that the actual turbine gave a considerably better efficiency than the model. This is, however, only what might be expected on account of the difference in size. It is to be noted that the experimental curves obtained from the model and the actual turbine are exactly similar in shape, thus showing that the latter is an exact enlarged reproduction of the former. The extremely simple shape of the runner buckets is doubtless one reason why the performance of the experimental model were identical with those of the large turbines.

Test Results Obtained with Turbine No. V., Delivered by J. M. Voith, Heidenheim.

The test was carried out on November 1st and 2nd, 1922, under the direction of a commission, consisting of Mr. Schmitthenner, Dr. Ing., Heidenheim; Mr. H. Thoresen, hydraulic engineer, Kristiania, with Professor G. Sundby, Trondhjem, as referee. Water level observations and measurements of water

† See the publication by Professor Hjalmar O. Dahl in *Tekn. Tidsskrift*, Mechanical Section, 1919, No. 12.

The relation between guaranteed and obtained efficiencies at 40ft. net head and 107 revolutions per minute, was as follows :—

Output in horse-power	4,800	7,200	9,600	10,800	12,000
Guaranteed efficiency, per cent.	65	76.5	83.5	85	79
Efficiency obt'ned, per cent.	72.3	78.0	84.2	84.3	81.3

According to the curve the best efficiency is at 10,400 horse-power and amounts to 85 per cent.

The efficiencies obtained were thus, especially at smaller loads, better than the guaranteed figures, even though such high values were not recorded for the large outputs as were obtained with turbines Nos. I. to III. On the other hand, for outputs below 6000 horse-power, the efficiencies were higher than those obtained with turbines I. to III., and the water consumption with no load on the turbine is less. Compared with the results obtained with the model turbine, higher efficiencies could reasonably have been expected. However, the buckets had been slightly misplaced in the mould at the steel foundry, which caused a discrepancy between the shape of the machine and that of the model runner, which discrepancy resulted in the water consumption and the efficiency above the corresponding point on the curve for IV.-VI., while, on the other hand, the latter curve is flatter than the former.

The runners of the two makes of turbine, which were constructed on the basis of each individual firm's experience and model test, are essentially different in appearance and form. The Verkstadens runner has few and short buckets of a remarkably plain form, whereas the Voith runner has a larger number of buckets with larger prolonged surfaces. In the latter runners greater stress has been laid upon rigidity, and hence the large number of buckets. Against the use of the large number of buckets and long water passages, is the fact that a small dislocation of buckets in the mould will produce a larger influence on their behaviour, and it is natural to attribute the reason for the discrepancy between the efficiency curves for the model and the large turbine to this fact.

Table II.—*Results of Efficiency Tests on Turbine V., Raanaasfoss, November 1st and 2nd, 1922.*

11.05–12.05	118.320	118.310	118.322	105.089	105.055	13.265	13.263	40	3.18	109.9	402	18.88	12.10	105.6	357	18.22
12.50–1.55	118.220	118.130	118.146	105.187	105.245	12.975	12.959	208	3.77	109.0	13,275	95.48	80.47	106.0	12,201	92.84
2.15–2.25	118.180	118.100	118.116	105.260	105.297	12.883	12.856	208	3.50	103.3	12,980	—	—	100.8	12,074	—
2.35–2.40	118.160	118.070	118.084	105.275	105.315	12.845	12.809	208	3.825	115.5	13,035	—	—	112.96	12,192	—
2.55–4.00	118.130	118.078	118.084	105.278	105.343	12.787	12.806	167	3.83	108.0	11,475	79.69	84.33	105.63	10,738	77.94
4.02–4.12	118.095	118.034	118.056	105.284	105.375	12.720	12.772	167	3.72	103.7	11,380	—	—	101.56	10,690	—
4.35–5.35	118.060	118.017	118.022	105.308	105.368	12.692	12.714	145	3.71	108.6	10,080	70.72	84.08	106.6	9,532	69.42
5.42–5.52	118.035	117.999	117.998	105.314	105.350	12.685	12.684	145	3.57	103.7	10,128	—	—	101.91	9,612	—
5.58–6.06	118.025	117.988	117.997	105.320	105.355	12.670	12.671	145	3.85	112.7	9,808	—	—	110.81	9,323	—
6.20–7.15	118.020	117.997	118.000	105.280	105.318	12.702	12.711	117	3.53	107.0	7,560	56.68	78.70	105.04	7,152	55.65
7.22–7.27	118.010	117.988	117.998	105.275	105.280	12.730	12.723	117	3.50	103.25	7,649	—	—	101.32	7,226	—
7.32–7.37	118.010	117.988	117.985	105.285	105.290	12.720	12.700	117	3.65	111.5	7,507	—	—	109.5	7,112	—
11.40–12.50	118.150	118.140	118.149	105.039	105.098	13.052	13.090	83	3.50	109.5	4,897	39.34	71.32	105.92	4,425	38.05
12.56–1.01	118.140	118.131	118.137	105.065	105.100	13.040	13.072	83	3.45	103.0	5,061	—	—	99.7	4,592	—
1.08–1.13	118.150	118.142	118.142	105.078	105.100	13.050	13.064	83	3.50	123.0	4,697	—	—	119.1	4,265	—

The Babbacombe Cliff Light Railway Order, 1923, which has recently been made by the Minister of Transport, authorises the construction of a light railway in the Borough of Torquay.

Pneumatic Grain Elevators.

No. III.*

By Professor W. CRAMP, D.Sc., and A. PRIESTLEY, M.Sc.

(12) Friction of the Grain on the Pipe.

Empirical Pressure Formula for a Vertical Elevator.—The vacuum $p_o - p_1$ at 9 m. from the nozzle was measured during the tests. From this and the air velocity V_{a_1} at the same point, we are enabled to estimate approximately the friction of the grain on the pipe walls, making use of equation (12).

For in the case of a pipe having a length not less than 9 m.—

$$V_f = V_a - \sqrt{\beta \frac{w}{a}} \quad . \quad . \quad . \quad (20)$$

And since from the tests all the quantities involved in these two equations, except β and V_f are known, we proceeded to determine these two. We thus found—

$$\beta = 1 + .018 \frac{V_f^2}{\sqrt{L}} \quad . \quad . \quad . \quad . \quad (21)$$

and it is not difficult to show that there is a rational basis for this form.

For on turning to page 35, we find that $\beta = \frac{w + f_g}{w}$ and $f_g = \frac{C}{\sqrt{L}} \cdot f_g'$, where C is a constant.

Let us make the assumption that f_g', the actual force of friction, varies directly as the square of the grain velocity V_g, and therefore very nearly as the square of the final grain velocity V_f (except in very short pipes).

Then $f_g = \frac{C'}{\sqrt{L}} \cdot V_f^2$, where C' is a constant, and

$$\beta = \frac{w + f_g}{w} = 1 + \frac{C''}{\sqrt{L}} V_f^2, \text{ where C'' is a constant.}$$

This expression is of the form of equation (21).

The fact that, according to (21), β is greater for small loads than for large ones, affords an explanation of the fact that the horse-power per ton per hour in these tests is greater for small than for large loads.

We now return to equations (12) and (20), substituting the value of β from equation (21). If we express $p_o - p$ in centimetres of mercury, and $\frac{L}{F}$ in tons per hour per square centimetre of pipe area, equation (12) becomes—

$$p_o - p = 20.7 \frac{L}{F} \left\{ \frac{V_f}{9.81} + \frac{S}{.8} \left(\frac{1}{V_f} + \frac{.018}{\sqrt{L}} V_f \right) \right\}$$

$$= \frac{L}{F} \left\{ \left(2.1 + \frac{.46}{\sqrt{L}} \cdot .8 \right) V_f + 26 \frac{S}{V_f} \right\} \quad (22)$$

Again, equation (20) becomes—

$$V_f = V_a - \sqrt{(1 + C \cdot V_f^2) \frac{w}{a}};$$

where $C = \frac{.018}{\sqrt{L}}$.

$$\therefore V_f = \frac{2 V_a \pm \sqrt{4 V_a^2 - 4 \left(1 - C \frac{w}{a}\right)\left(V_a^2 - \frac{w}{a}\right)}}{2 \left(1 - C \frac{w}{a}\right)}$$

The negative sign must obviously be taken—

$$\therefore V_f = \frac{V_a - \sqrt{\frac{w}{a} \left\{ C \left(V_a^2 - \frac{w}{a} \right) + 1 \right\}}}{\left(1 - C \frac{w}{a}\right)}$$

Inserting the values of C and $\frac{w}{a}$, $\left(\frac{w}{a} = 54\right)$

$$V_f = \frac{V_a - \sqrt{\frac{.97}{\sqrt{L}} (V_a^2 - 54) + 54}}{1 - \frac{.97}{\sqrt{L}}} \quad (23)$$

In order to show that these expressions give approximately correct results, we will now apply equations (22) and (23) to calculate the vacuum in a number of the tests. The air friction and acceleration loss p_a must be added to the calculated vacuum $p_o - p$, and the result should then equal the actual vacuum observed in the tests. Table III. shows the result of these calculations, side by side with the experimental results, and it will be seen that the agreement is fairly close.

The formulæ may be used, with caution, for estimating the vacua in pipes of other lengths and diameters, but we should not expect them to give accurate results for pipes much less than 9 m. long, for air velocities greater than 40 m. per second or for vacua much above 25 cm. mercury.

To make formula (22) complete, we may add expressions for the loss of pressure due to air friction and acceleration, deduced from equations (8) and (10). The complete equation for calculating the vacuum in a vertical elevator pipe then becomes—for wheat $\frac{w}{a} = 54$ (metres per second)^2 :—

$$p_o - p = \frac{L}{F} \left\{ \left(2.1 + \frac{.46}{\sqrt{L}} \cdot .8 \right) V_f + 26 \cdot \frac{S}{V_f} \right\} + .0011 \frac{V_a^2 \cdot S}{d} + .00092 V_a^2 \quad . \quad (24)$$

V_f having the value given by equation (23).

Where $p_o - p$ = vacuum (centimetres mercury);
S = length of pipe (metres);
F = area of pipe (square centimetres);
d = diameter of pipe (centimetres);
L = grain load (tons per hour);
V_f = grain velocity at top of pipe (metres per second);
V_a = air velocity at top of pipe (metres per second).

(13). Nozzles.

We have hitherto been dealing with the efficiency of transmission of a conveyor pipe in which a given load is passing, but we have not considered the question of how that load is introduced into the pipe. We shall find, however, that for any given air velocity in the pipe, there is a definite limit to the load which will be drawn into the pipe in a given time through any particular form of nozzle. Suppose we have a conveyor pipe in which air is passing, the velocity of the air at the nozzle being sufficient to lift the grain. Let the nozzle be plunged below the surface of a mass of grain. The grain immediately adjacent to the nozzle will be rapidly accelerated and carried into the pipe, leaving a partial cavity round the nozzle. Into this cavity the surrounding grain falls from all sides, but most freely from above, under the force of gravity. For any given velocity of the air at the nozzle, it will be found that a definite weight of grain per second per unit area of nozzle is drawn into the pipe. It would appear that the factor which limits the amount of grain drawn in is the rate at which the grain can fall under the action of gravity towards the nozzle; for, as will be seen, a nozzle placed in a horizontal position will draw more than the same nozzle placed vertically. We studied the flow of grain towards the nozzle by making one side of the grain box of glass, and placing the nozzle close to the side. In the case of a vertical nozzle, most of the grain descends vertically to the nozzle by a path close to the side of the pipe. The motion is suddenly reversed at the nozzle, and the grain drawn upwards into the pipe. In order to effect this reversal quickly, a strong current of air is required at the nozzle. With a horizontally placed nozzle, the "stream lines" followed by the grain have much less curvature, and the grain flows into the nozzle with less assistance from the air.

To try this effect of position, as well as to ascertain the general effect of the nozzle shape, a number of tests were made with the apparatus of Fig. 2 *ante*, and the results are summarised below. In each test the nozzle was immersed to a depth of 12in. or 14in. in a box of grain and allowed to take all it would. It was then found that the load in tons per hour per square inch of nozzle area, divided by V_{a_o}, the velocity of the air in metres per second at the nozzle was nearly constant for any one type or position; and this ratio we termed the nozzle constant n. No auxiliary air inlet was used in any case. The experiments were made with nine nozzles, as follows:—

Type I.—Vertical circular nozzle, area 18 square centimetres; n had a constant value of about .022 for values of V_{a_o} of 10 m. to 16 m. per second (fifteen tests).

Type II.—Vertical circular nozzle, area 31 square centimetres; n had the same value as for Type I. Owing to the larger area, however, V_{a_o} is reduced to 9 m. per second, which is only just sufficient to lift the heaviest grains. The flow is becoming unstable.

Type IV.—Vertical elliptical nozzle, area 27 square centimetres; n has still the same value as for Type I. Elliptical axes, 7.6 cm. and 4.6 cm. respectively.

Type V.—Vertical rectangular nozzle, area 18 square centimetres (8 × 2.25 cm.). Though the area is the same as for Type I., n dropped to .018. This is probably because the mouth was so narrow (2.25 cm.) that the streams of grain entering at opposite sides interfered with one another.

Type III.—Vertical circular nozzle, area 80 square centimetres. Here, as in Type II., owing to the large area, V_{a_o} is much reduced, being, in fact, only 3.4 m. per second when calculated on the full nozzle area—a velocity apparently insufficient to lift any grain. Owing, however, to the presence of the slowly moving grain at the entrance to the nozzle, the effective area is reduced, and the velocity of the air relative to the grain is greater than 3.4 m. per second. For this nozzle n dropped to about .017, partly perhaps on account of the low value of V_{a_o}, but probably also for the reason given under the next type.

Type VI.—Vertical rectangular nozzle, area 86 square centimetres (17.5 × 4.9 cm.). For this nozzle V_{a_o}, calculated on the full nozzle area, is 3.1 m. per second, which is even less than for the circular nozzle of Type III. The grain flow was unstable; yet n rose to about .023, the value for Type I. The reason may be that in the large circular nozzle—Type III.—there is an "idle" patch at the centre through which very little grain is lifted, though air leaks in there uselessly. By examining the action of a vertical nozzle placed behind a glass plate, it is seen that most of the grain enters immediately round the perimeter of the nozzle, the disturbance immediately underneath being small. For large nozzles we should perhaps choose a form in which the perimeter is large in relation to the area, as in Type VI., rather than the circular form.

Type VII.—Vertical circular nozzle, as Type II., but blocked at the bottom, and having one rectangular opening at the side of area, 17 square centimetres; n had a value of .030, which is intermediate between Types I. and IX., as might have been expected.

Type VIII.—Similar to Type VII., but with two rectangular openings placed opposite one another, of combined area 31 square centimetres. Here n fell to .022, either because the two opposing streams of grain interfered with one another, or because, owing to the larger area, V_{a_o} was reduced to 9 m. per second, and the grain flow became unstable.

Type IX.—Horizontal circular nozzle, area 18 square centimetres. The nozzle in these tests was thrust horizontally into the grain through an opening in the side of the box. Owing to the high vacuum, the receiver leakage was excessive, and there is some little doubt about the value of V_{a_o}. n, however, was about .048, *i.e.*, twice the value for Type I. (the same nozzle placed vertically). This is probably due to the easy path along which the grain approaches the nozzle, without sharp change of direction; and also to the fact that there cannot well be any "idle" patch through which grain does not enter.

The above tests are neither conclusive nor exhaustive, and further experiments with nozzles are needed. The question should also be considered of introducing more grain into the nozzle by external means, such as an auxiliary air jet.

We shall now show the importance of using a nozzle with a high value of n.

(14) Value of Nozzle Constant in Relation to Design of Plant.

From the tests described in the last paragraph there is some reason to suppose that for a given type of nozzle—

$$\frac{L}{F_o} = n \cdot V_{a_o};$$

where n is the "nozzle constant" for that particular type of nozzle.

Now—

$$V_{a_o} = \frac{F}{F_o} \cdot \frac{p}{p_o} \cdot V_a \text{ (approximately).}$$

$$\therefore \frac{L}{F} = n \cdot \frac{p}{p_o} \cdot V_a = n \left(1 - \frac{p_o - p}{p_o} \right) V_a \quad (25)$$

For given values of V_a and n, this equation gives

Table III.—*Calculated and Actual Vacua for Vertical Pipe, 9 m. long, 4.6 cm. diameter. Wheat* $\frac{w}{a} = 54$.

Experiment No.	L, tons per hr.	$\frac{L}{F}$ t.p.h. cm.^{2}	V_a metres per sec.	V_f metres per sec.	β	$p_o - p$ (calculated) cm. mercury.	p_a cm. mercury.	Vacuum (calculated), cm. mercury.	Vacuum (actual), cm. mercury.
2	1.39	.077	20	9.0	2.24	5.9	1.4	7.3	7.2
4			30	14.7	4.30	7.6	2.9	10.5	10.8
7			41	20.7	7.56	9.8	5.0	14.8	13.5
2	2.38	.132	19	8.8	1.90	9.0	1.4	10.4	11.2
4			33	17.4	4.51	12.7	3.4	16.1	16.8
6			40	21.5	6.38	14.9	4.8	19.7	17.8 (?)
2	3.72	.207	19	9.2	1.79	13.3	1.3	14.6	15.3
4			29	15.7	3.29	16.9	2.7	19.6	19.6
11			37	20.6	4.97	20.4	4.2	24.6	23.8
3	4.85	.269	18	8.7	1.62	16.5	1.2	17.7	18.0
5			26	14.1	2.62	19.6	2.3	21.9	22.3
7			34	19.2	4.02	23.8	3.6	27.4	26.4
1	6.3	.35	27	15.0	2.6	25.0	2.4	27.4	27.5

* No. II. appeared January 18th.

a relation between $\frac{L}{F}$ and the vacuum $p_o - p$ at the top of the pipe.

A second relation between the same quantities is given by equation (24). These relations give two simultaneous equations by which the load drawn into the pipe and the vacuum at the top of the pipe may be determined, when the air velocity at the top of the pipe and the nozzle constant are known. In Fig. 6 the slightly curved lines show the relation between load per square centimetre and vacuum, as given by equation (24) for various values of V_a and F. The straight lines show the relation between load per square centimetre and vacuum for various values of V_a and n, as given by equation (25).

The point where corresponding curves cross shows the actual load per square centimetre and vacuum which will hold when a vertical pipe, 9 m. long of area F, is drawing wheat $\left(\frac{w}{a} = 54\right)$, through a nozzle whose constant is n, the air velocity at the top of the pipe being V_a. A few of these cases, determined from Fig. 6, are given in Table IV.

TABLE IV.—*Relation of Nozzle Constant n to Load and Vacuum.*

Vertical pipe, 9 m. long. Wheat $\frac{w}{a} = 54$ (metres per sec.²).

Case.	$n = \frac{L}{F_a} \div V_{a_o}$	Air velocity, metres per second. Top V_a.	Nozzle V_{a_o} (approx.).	$\frac{L}{F}$ tons per hour per sq. cm.	F pipe area, sq. cm.	L_t tons per hour.	$p_o - p$ Vacuum, cm. mercury.	Horse-power, per ton per hour.
1	.02	20	15	.31	72	22.2	17	.17
2	.05	20	12	.59	72	42.5	31	.14
3	.02	20	15	.30	18	5.4	20	.20
4	.05	20	11	.56	18	10.1	34	.16
5	.02	40	20	.41	72	29.5	37	.45
6	.05	40	12	.61	72	43.9	53	.32

The power in the last column has been calculated from the equation (19*a*) on page 65, adopting the correct value of F.

In considering the results of Table IV., it will be seen that there are many variables. We must now

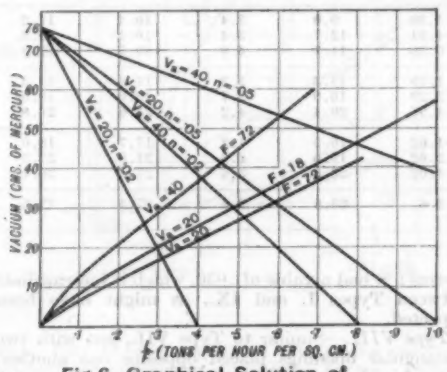


Fig.6. Graphical Solution of Equations

consider whether any of these variables have fixed limits which cannot be exceeded.

(1) *Nozzle Constant n.*—This, as we have seen, is a constant for any given type and position of nozzle. Two values have been chosen as examples in Table IV., viz., .02 and .05, these being the values for a circular nozzle, 4.8 cm. diameter, held respectively vertically and horizontally. n may be *reduced below* these values by the device of an auxiliary air inlet—see below.

(2) *Nozzle Velocity* V_{a_o}.—The air velocity at the nozzle must always be sufficient at least to lift the grains. The value of this minimum velocity is considered below. It should be noted that this is a distinct question from that of the "drawing power" of the nozzle, which depends upon n.

(3) *Vacuum* $p_o - p$.—Leakage troubles increase as the vacuum increases. Further, owing to the great expansion of the air at very high vacua, large pump capacity becomes necessary. A pump vacuum of about 25 cm. of mercury is a usual vacuum for many plants working to-day. If plants could be designed to work at, say, 50 cm. vacuum without serious leakage, much higher loads could be taken by a given pipe than is at present the case.

(4) *Air Velocity* V_a *at Top of Pipe.*—Having fixed upon V_{a_o} and $p_o - p$, V_a is, of course, also determined—assuming the ratio of the nozzle area to the pipe area to be known. The only upper limits imposed upon V_a appear to be practical ones, such as pump capacity and excessive air friction in the pipe and pump.

(5) *Load Density* $\frac{L}{F}$.—The tests recorded were carried up to a load density of .35 ton per hour per square centimetre of pipe area. None of the alleged trouble or instability, due to the "crowding" of the grain, was experienced up to this value, though there is no doubt some practical upper limit to load density. The above value is already far above that occurring in most commercial plants.

The U.S. Battleship Colorado.

IN the vocabulary of the naval student the term "post-Jutland" has already acquired a significance as profound as that which attaches to "Dreadnought" and "pre-Dreadnought." It is applied to capital ships designed after the naval action in the North Sea on May 31st to June 1st, 1916, which are understood to embody new principles of construction, protection, armament, and equipment suggested by the experience gained in that action. In consequence of the Washington Treaty, very few ships of this particular type have been, or will be, built. Including H.M.S. Hood—which, however, only partially incorporates the new features referred to above—there are six post-Jutland ships now afloat, a number that will be increased to eight when our new vessels—Nelson and Rodney—glide down the ways. Three out of the six belong to the United States Navy, viz., Maryland, Colorado and West Virginia; whilst the Nagato and the Mutsu are units of the Imperial Japanese Navy.

The Colorado visited Portsmouth early this month in the course of a trial cruise lasting six weeks, the object being to "shake down" the machinery and enable the ship's company to become familiar with the working of the vessel before she joins the battle fleet in the Pacific, to which command she has been assigned. Thanks to the good offices of the American Embassy and the courtesy of the ship's commanding officer, Captain Reginald R. Belknap, U.S.N., a representative of THE ENGINEER was able to make a thorough inspection of the Colorado while she lay at Portsmouth. The following description is based upon notes and impressions obtained at first-hand, supplemented by data from other reliable sources, including American official documents.

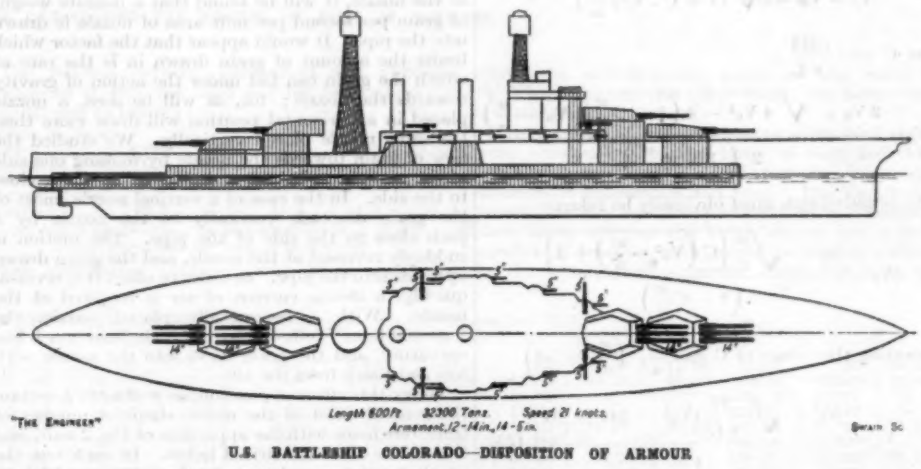
The Colorado is one of a class of four ships built under the programme of 1916, though she was not laid down until May, 1919. The delay was occasioned by America's intervention in the Great War, and advantage was taken of it to recast the design in accordance with the more reliable and detailed information which became accessible to American constructors. The first of the class to be completed was the Maryland, which made her trials in the summer of 1921; the Colorado was launched on March 22nd, 1921, at the Camden, N.J., yard of the New York Shipbuilding Company, and commissioned last October; the West Virginia has just been completed, while the fourth unit of the class, the Washington, has been sold for demolition as prescribed by the Naval Treaty.

When viewed broadside on the Colorado is not easy to distinguish from the California and the Tennessee, which constitute the preceding class of battleship. Her outline is, in fact, almost identical with theirs, but from any other angle of vision she is at once recognisable by her double turrets. Externally, the features that first arrest the eye are the two lattice masts, the pair of diminutive funnels, the huge conning-tower flanked by lofty bridges, and the pronounced clipper bow, which is pierced by a centre-line hawse pipe for the sheet anchor, and projects no less than 24ft. beyond the fore perpendicular. This type of stem first appeared in the New Mexico—laid down in 1915—and was adopted for the two-fold purpose of keeping the forecastle dry when the ship is steaming against a head sea and of reducing the damage likely to be caused to any vessel which the battleship may accidentally ram. It is very improbable that a blow from the Colorado's stem would inflict injury below the water-line in the event of such a collision. Lattice masts were introduced some eighteen years ago as a standard pattern for all heavy ships of the United States Navy, at the instance, we believe, of Admiral Sims, with the object of providing a stable platform for fire-control purpose, and as a convenient method of carrying signal and W/T yards without the support of stays or shrouds. In form, the mast is a hyperboloid of revolution, built up of hollow steel rods secured to a ring on the top deck. In the earlier ships it proved successful enough, though inclined to "whip" somewhat violently under the concussion of gun discharge; but with the addition of heavy tops for the director towers and other gear associated with modern fire-control installations, this form of mast is no longer regarded with complete favour, and many American officers admit their preference for the tripod mast. Repeated tests have shown the lattice mast to be almost indestructible by shell fire. On the other hand, it would be liable to go bodily over the side if the top deck to which alone it is secured were damaged in its vicinity.

The leading dimensions of the Colorado are as follow:—

Length between perpendiculars	600ft.
Length over all	624ft.
Length of straight keel	539ft.
Breadth, extreme	97ft. 3½in.
Draught, mean	30ft. 6in.
Draught, maximum	31ft. 3½in.
Displacement, normal	32,600 tons
Displacement, at full load	33,590 tons

The hull is constructed by the usual method, involving a combination of the transverse and longitudinal systems. Weight is saved in every way possible, the scantlings being somewhat lighter than those of modern British battleships. The subdivision of the hull below the water-line is very complete. It corresponds closely to that of the "California" class, which Mr. S. V. Goodall, of the Royal Corps of Naval Constructors, described in his invaluable paper read before the Portsmouth Engineering Society in January, 1922: "It consists of a system of longitudinal and transverse bulkheads, the former being closely spaced about 3ft. apart, and the latter staggered so that damage to one will not extend right into the inmost longitudinal bulkhead. The outer and inner of the five wing compartments are air spaces, and the three central compartments are oil fuel tanks. All the compartments are severely tested before acceptance, the pressure head for water test being 44ft. Inside these bulkheads the main hull is well subdivided both longitudinally and transversely. This arrangement was adopted after an extensive series of trials on a large scale. It is evidently based on the principle of keeping the centre of disturbance a considerable distance from the bulkheads bounding important compartments and absorbing the energy by the progressive rupture of bulkheads and the compression of fluid." In effect, there are four successive spaces between the outer hull of the ship and its vital parts, so that, theoretically, the ship should be able to endure very heavy punishment through underwater attack without being reduced to sinking condition. If, however, a torpedo were to explode when the oil tanks were empty, the consequences might be more serious, and in any case such an explosion would open the middle deck to the sea. To provide against the first contingency, it is arranged that the oil tanks, when empty, shall be filled with salt water. Whether this system of subdivision is, on the whole, equal or superior in efficiency to the bulge method of protection remains a debatable point.



U.S. BATTLESHIP COLORADO—DISPOSITION OF ARMOUR

The disposition of the Colorado's armour—which is clearly shown in the accompanying diagram—

is essentially the same as that adopted in the "Nevada" class, laid down in 1912, following a series of experiments against armoured ship targets. As a result of these tests it was decided to abandon vertical armour on all parts where plating of sufficient strength to keep out heavy projectiles could not be fitted, and to concentrate defence on the water-line, the gun positions, and other areas where shell penetration would be likely to cause serious damage. In pursuance of this policy the topsides are left unarmoured, as also is the secondary battery; but this absence of protective plating is held to be an advantage, as it would allow projectiles to pass freely through the ship without being brought to explosion, as they would be if they encountered armour just stiff enough to act as a burster without being sufficiently strong to keep them out. In the Colorado the main belt has a maximum thickness of 16in. at the water-line, tapering to 8in. at the lower edge. It is about 16ft. deep, 6½ft. being submerged when the ship is at normal displacement. It extends from a point some 30ft. forward of No. 1 turret to within a short distance of the stern, and is

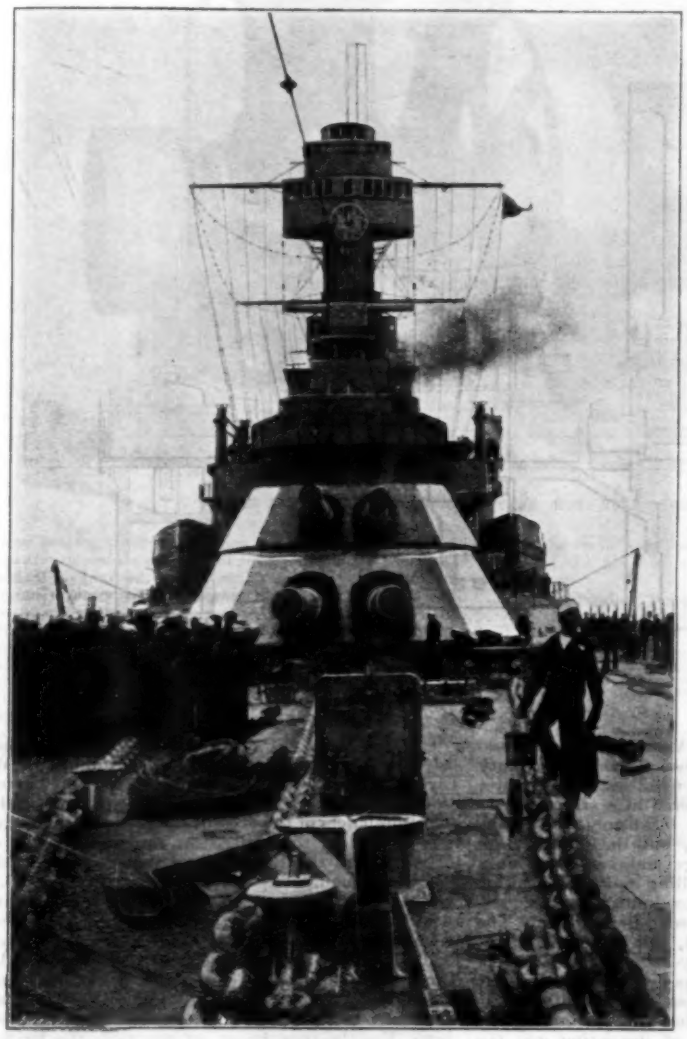
The main armament of the Colorado comprises eight of the most powerful guns at present mounted afloat—16in. 45-calibre built-up pieces, weighing 105 tons. Fired with a full charge this gun develops a muzzle energy of 98,406 foot-tons, and imparts to its 2100 lb. projectile an initial velocity of 2800 foot-seconds. The extreme range at an elevation of 30 deg. is 32,000 yards. The guns in each turret are separated by a thin partition which has no protective value, and is, presumably, only fitted to prevent interference between the two gun crews. At the rear of the gun-house there is a compartment for the officer-of-turret, which contains, besides a 30ft. base range-finder—whose extremities project well beyond the outer walls of the turret—a complete installation for controlling the fire not only of that individual turret, but of the other six guns as well. Consequently, each of the four turrets is a self-contained station from which the entire main battery of the ship could be controlled if the main G.C.T. were put out of action; though, for obvious reasons, the fire of the ship would be much less effective, especially at long range, if controlled from one of

two battleships of the "Nelson" class are in service.

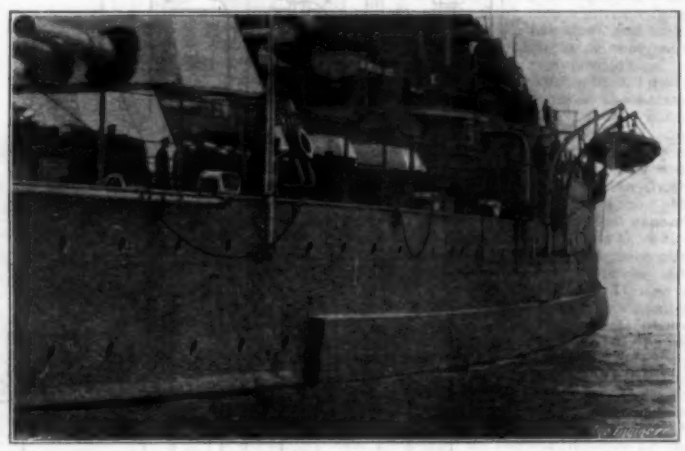
In an enclosed but unarmoured battery above the forecastle deck ten 5in. 51-calibre quick-firing guns are mounted, two more weapons of this type being carried on the superstructure. This mark of gun fires a 50 lb. projectile and uses a brass cartridge case. It gives an initial velocity of 3150 foot-seconds and a muzzle energy of 3459 foot-tons. The rate of fire under favourable conditions should exceed 11 rounds a minute. There are, in addition, eight 3in. 50-calibre anti-aircraft guns, mounted at commanding points on the shelter deck. Two 21in. torpedo tubes are fitted in the forward part of the ship, to port and starboard respectively.

THE PROPELLING MACHINERY.

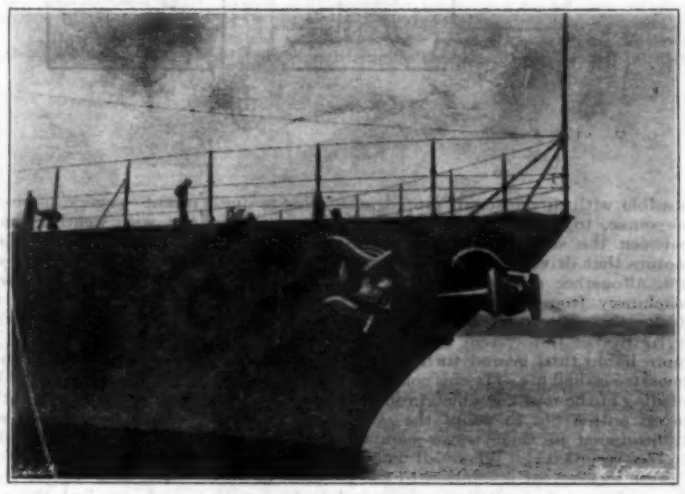
Whereas the propelling machinery of her sister ships, Maryland and West Virginia, was supplied by the General Electric Company, that of the Colorado was manufactured by the Westinghouse Company, though it does not differ in any essential feature from the plant installed in the other two ships. It consists



QUARTER DECK



VIEW SHOWING LOCAL ARMOUR-PLATING



CLIPPER BOW AND ANCHORS

there continued, at a reduced thickness of 8in., to as far aft as the rudder head. As the plates are fitted vertically and keyed at the butts, the belt stands out from the side of the hull and is, therefore, very conspicuous, as will be seen from the photographs we reproduce. Above the belt is a flat deck 3½in. thick, with a second, but lighter, protective deck below it. Beyond the extremities of the belt, horizontal armour 6in. thick is worked to within 25ft. of the bow and right aft as far as the steering gear, which it completely protects. The funnel uptakes and the trunk supplying air to the boiler and engine-rooms are heavily armoured up to the level of the forecastle deck. Each barbette is constructed of 13½in. armour; the sides of the gun-house are 10in. thick, the port plate is 18in., the roof 5in., and the rear wall 9in. thick. The conning-tower and its tube are built up of 16in. armour, roofed over with 8in. plates. In spite of this massive protection to vitals, the aggregate weight of armour is less than might be supposed, for the plated area of the ship is relatively small. Under the attack of high-explosive shell the topsides and auxiliary battery would probably be wrecked, but it is not believed that superficial damage of this kind would impair the fighting efficiency of the ship. The conning-tower is a large octagonal structure, standing well clear of the bridges, to which it is connected by a light gangway.

these low-lying stations whence the field of vision is restricted, and would be further obscured by smoke and shell splashes. All main and secondary guns in the Colorado are director-controlled.

The lay-out of gun-house and barbette shows a radical departure from British practice, the difference being due, in large measure, to the use of electricity for all manœuvring and loading operations in place of the hydraulic power employed in our Service. Immediately above the roller path a complete deck is worked across the gun-house, with a depression into which the breech of the gun recoils after firing at high elevation. The gun-house proper is thus completely shut off from the compartment below, *i.e.*, the power-handling room—and the flash of a shell detonating in the gun-house could not pass into that compartment unless the hoists had been holed. Loading takes place at a fixed angle of elevation. The mountings provide for elevation up to 30 deg., and for 5 deg. of depression. The breech of the gun rotates about a horizontal axis downwards, and is worked by springs or pneumatic gear. We were informed that a well-drilled crew would have no difficulty in loading the gun in 45 sec. At this rate the ship could deliver four full salvos of eight guns each every 3 min., equivalent to a total discharge of 30 tons of projectiles. No guns comparable in power with those of the Colorado will be mounted in the British Navy until our

in the main of two sets of turbines taking steam from eight Babcock and Wilcox boilers and directly connected with two alternators; two main condensers; four two-phase induction motors connected to the propeller shafts; and two booster generating sets, deriving power from any one of six 300-kilowatt geared-turbine generating sets. The total weight of the machinery is in the neighbourhood of 1800 tons. Each boiler is housed in its own water-tight compartment, and each of the two engine-rooms with its turbo-generator is similarly isolated. The main air condensers, as also the main air and circulating pumps, are placed in a flat immediately below the turbines. Separate water-tight compartments are provided for the four main induction motors, each nominally developing 7000 shaft horse-power at 170 revolutions per minute and being directly connected to the propeller shaft. The advantages and drawbacks of the electric drive have been so well canvassed that we do not propose to touch on the subject here, beyond remarking that the engineer officers of the Colorado expressed themselves very favourably towards it on account of the ease and flexibility with which the ship could be manœuvred. While the system does not, apparently, make for economy in weight, space, or fuel consumption, it has the great merit from the naval constructor's point of view of permitting a much closer subdivision of the machinery spaces than is

HOT-BULB ENGINE WITH ROLLER BEARINGS

S. RICHARDS AND CO., LIMITED, LOWESTOFT, ENGINEERS

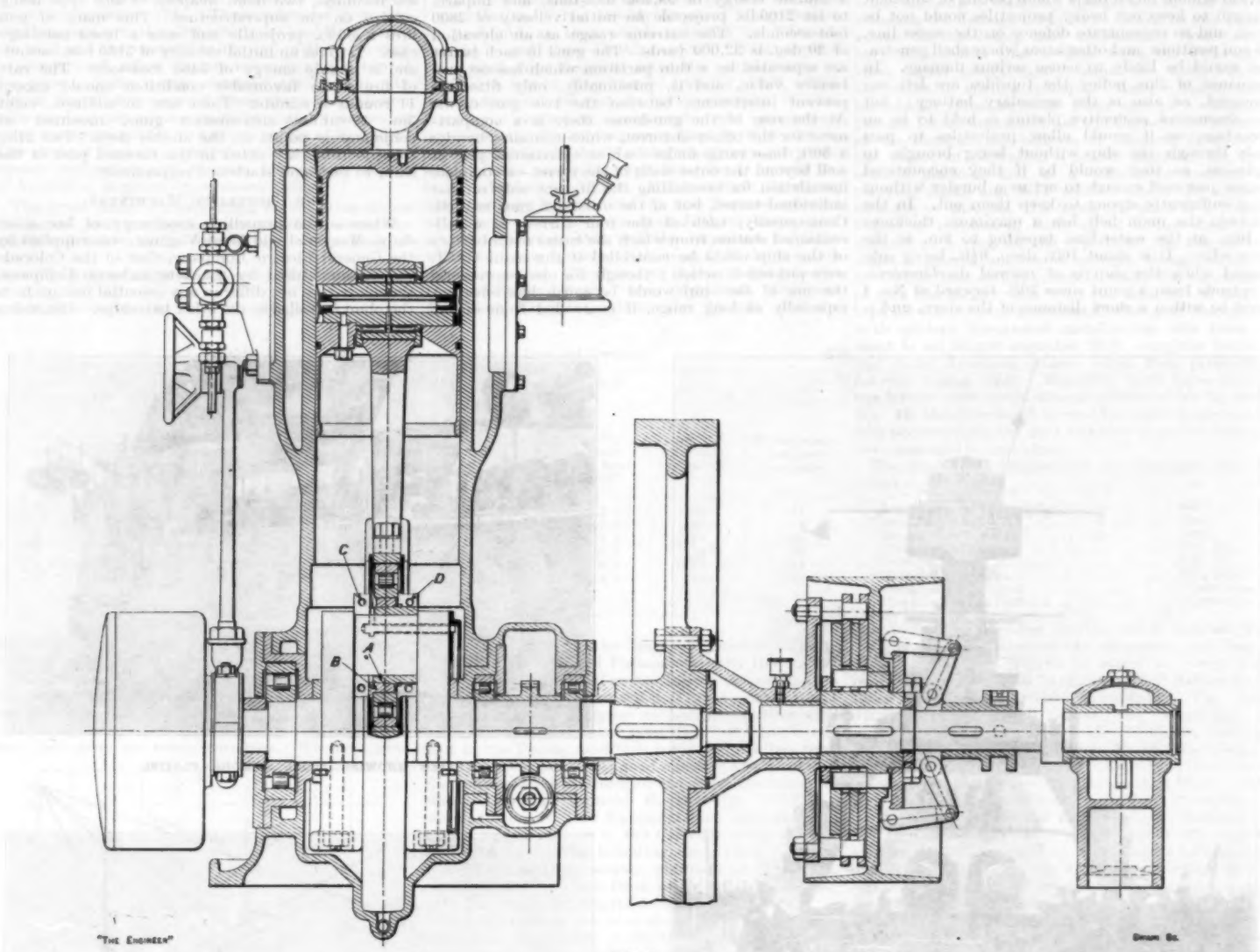


FIG. 1

possible with direct steam propulsion. This is due, of course, to the absence of mechanical connection between the shafting and the main engines. The motors that drive the propellers can be, and in fact are, altogether out of alignment with the turbine machinery from which, in the first instance, they derive their power. On the other hand, it is argued by critics of the system that electric machinery is more liable than geared turbines to suffer derangement from shell fire. In this connection Mr. Goodall's reading of the motives which prompted the American naval authorities to adopt the system of electrical transmission in their newer capital ships deserves to be recorded: "When all engineers," he says, "were looking for a solution to the problem of how to combine a fast-running economical turbine with a slow-running economical propeller, national traits became evident. I believe our marine and mechanical engineers always have been, and still are, second to none in turbine design and gear-cutting; they have perfected gearing and the turbine with its elements for economic performance at cruising speeds. On the other hand, electrical engineering science has been more highly developed in the United States, and electric propulsion is consequently more suited to the American temperament. Moreover, the situation of the United States and her possessions is such that American naval authorities attach great importance to radius of action. At the time they decided in favour of electric propulsion this system showed promise of such high economy, compared with the direct-turbine drive, that for this reason alone they were willing to adopt it; probably they did not foresee the possibility of similar economy through the adoption of mechanical gearing and improvements in turbines."

With all oil compartments filled to within 95 per cent. of their capacity, the Colorado can store 5000 tons of liquid fuel, which would, it is estimated, enable her to cover a distance of 12,000 sea miles at a speed of about 15 knots. She can also stow 575 tons of reserve feed water and 175 tons of fresh water. No data relative to her speed trials have as yet been published, but her sister-ship, the Maryland, made a 12-hour full-power run at a mean of 21.07 knots, developing 29,200 shaft horse-power and consuming 28,651.6 lb. of oil per hour—a consumption of .982 lb. per shaft horse-power. On her recent voyage across the Atlantic the Colorado met with weather that gave her a good opportunity of demonstrating her nautical qualities. The greater part of the distance was covered in a strong south-westerly gale, accompanied by heavy seas. She shipped little water forward, but the quarter-deck was frequently flooded. Her motions were easy in the worst weather; the rolling and pitching were in no way violent, and her steadiness as a gun platform left nothing to be desired. Being "stiff" she naturally proved rather wet, but from the point of view of fighting efficiency—if not from that of comfort—a steady ship is preferable to one that keeps her decks dry at the expense of stability.

The last capital ship of the United States Navy which we had the pleasure of inspecting was the Pennsylvania—*vide* THE ENGINEER of January 5th and 12th, 1917—and, as we recorded at the time, we were particularly impressed with the roominess and comfort of her berthing quarters, for the men no less than for the officers. In this respect the Colorado shows no advance, but rather a retrogression. Her mess decks, it is true, are roomy enough compared with the old type of battleship, but they lack that fine spaciousness that marked the same quarters in the Pennsylvania. This question of habitability is raised by Admiral Washington, of the Bureau of Navigation, United States Navy, in his annual report for 1923. As he points out, new developments and improvements in material have tended so to increase the *personnel* required to operate them that the men can no longer be berthed comfortably even on board the largest ships, and overcrowding results. This difficulty has, of course, been met with in our own Navy. As electricity is the motive power of the Colorado, it is natural that it should also be employed for working all the auxiliary mechanism of the ship. It is used, for instance, to operate the steering gear, raise and lower the anchors and boats, cool the magazines, ventilate and heat the ship, drive all water and oil pumps, cook food and bake bread, operate the ship's laundry, and work all machinery in the machine shop and carpenter's shop. A complete system of telephonic communication is installed, with more than a hundred loud-speaking telephones, 180 ship service telephones, and nearly 200 telephones for the gun and torpedo control services.

The Colorado, we may add, together with her sister vessels, was designed by Rear-Admiral D. W. Taylor, former Chief Constructor of the United States Navy, and, by common consent, one of the ablest designers of the present day. Admiral Taylor, it is interesting to recall, went through a course of instruction at the Royal Naval College, Greenwich, as a young man, and passed out with high honours.

Owing to the secrecy which is maintained with regard to the design of the "Nelson" class there is no vessel of the British Navy whose details are available for comparison with those of the Colorado. The Hood belongs to an entirely different type, and it would, therefore, be profitless to tabulate her characteristics alongside those of the American ship. For the time being, at any rate, the British Navy possesses no ship equal to her in offensive or defensive attributes. She and her two consorts form a squadron unmatched in fighting power and well fitted to serve as the spearhead of the American battle fleet.

A Roller Bearing Oil Engine.

THE hot bulb type of oil engine running at a moderate speed occupies a position intermediate between the high-speed petrol or paraffin motor and the heavy oil engine.

In recent years this form of prime mover has become increasingly popular for both industrial and marine uses, largely on account of its simplicity, its reasonable dimensions and its moderate cost, and to-day it is proving a keen competitor of the heavy oil engine from the smallest powers up to 500 and 600 brake horse-power per shaft.

On the marine side there is no doubt that the wide use of hot bulb oil engines in Scandinavia and Holland and the designs put forward by engine builders in these countries stimulated British enterprise. To-day, however, the British hot bulb engine is an important engineering product for both home and foreign markets.

One of the arguments advanced against crank case compression, which is generally a feature of the design of such engines, is the large amount of lubricating oil used. The air required for the working stroke when compressed in the crank case becomes contaminated in some degree with lubricating oil, and where copious supplies of oil are given to the bearings considerable waste may take place. In such cases as the fishing industry, where engines

are run largely by unskilled attendants, a good deal of trouble arises from insufficient attention to and ineffective lubrication of the main bearings of the engine, causing heating and seizure.

With a view to producing an engine which will be as free from bearing trouble as design can make it and which will use the minimum amount of lubricating oil, S. Richards and Co., Limited, of Crown Works, Lowestoft, have recently placed on the market a hot bulb engine, which is fitted with roller type bearings throughout. The intention of the makers is to build stationary and marine engines of from 15 to 75 brake horse-power sizes in single and multi-cylinder units, and we show in the accompanying illustration—Fig. 2—the first engine to be built. It is a single-cylinder model. The cylinder is 8½in. diameter, with a piston stroke of 10in., and the engine is designed for an output of 15 brake horse-power when running at a normal speed of 400 revolutions per minute. The amount of fuel oil used is stated by the makers to be under 0.7 lb. per brake horse-power hour, which figure is about normal for a small engine. With larger sizes it is expected that the fuel consumption will be correspondingly reduced. The amount of lubricating oil used is very small, a consumption of 0.005 lb. of oil per brake horse-power hour being guaranteed by the builders.

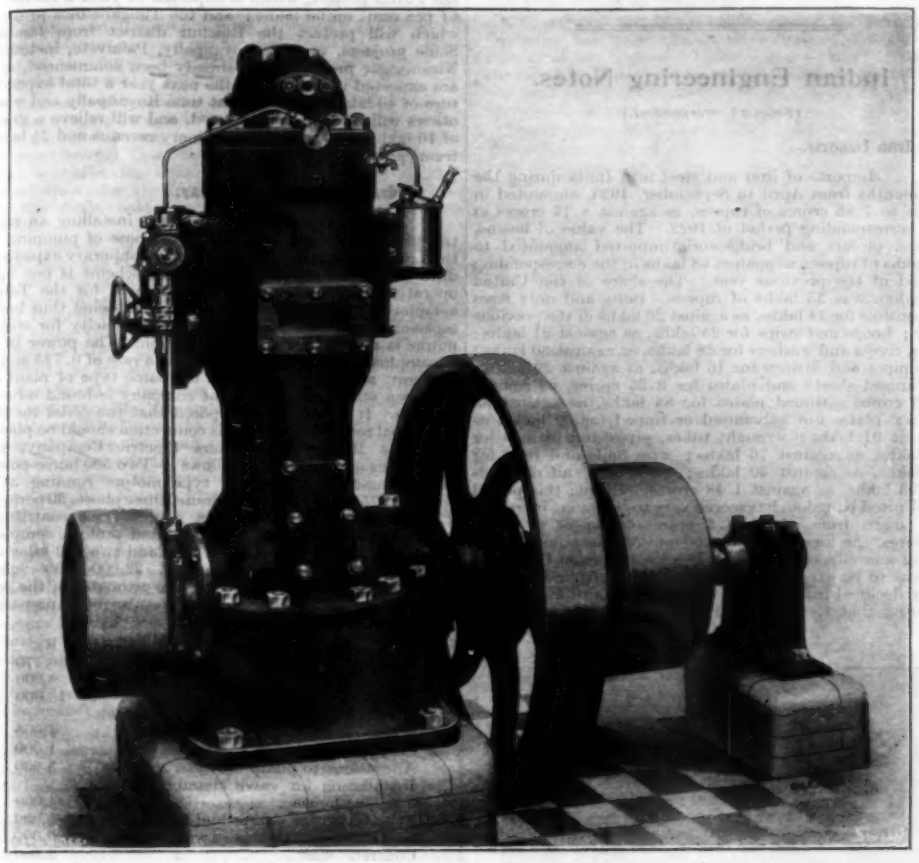


FIG. 2—RICHARDS STATIONARY-TYPE HOT-BULB ENGINE

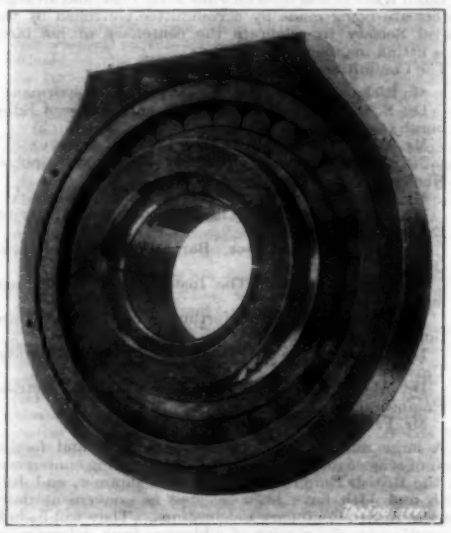


FIG. 3—BOTTOM END BEARING

The general lines of the engine are pleasing, and the design of cylinder column and bed-plate is such as to give compactness and strength. In the model we examined the cylinder casing and the liner are—as shown in Fig. 1—cast in one piece with the water jacket and the exhaust and scavenger air ports.

We are given to understand, however, that separate liners may be considered for the larger sizes of engine. A side facing on the column carries the fuel pump and fuel oil strainer, while a bracket on the opposite side serves to support the fuel container for the starting blow lamp. Access to the water spaces is given by inspection doors, and on the front of the column a door is provided which enables the bottom end and the interior of the crank case to be examined. On the back of the column is placed the air inlet valve, which is of the usual flat spring type.

The outstanding feature of this engine is the use of roller bearings, both on the main crank shaft and the connecting-rod top and bottom ends. The sectional elevation—reproduced in Fig. 1—shows the main bearing arrangement, and the way in which the roller bearing races are housed in the bed-plate casting. Hoffmann bearings of extra heavy cage-type, are used for the three main bearings. Number one bearing between the governor and the crank is slightly larger than numbers two and three on either side of the pump gear drive, but these two bearings are of the same size and are interchangeable. All bearing housings are carefully machined, so that oil is retained in the bearings, which run, therefore, in an oil bath. Under these conditions an extremely long life should be assured. At each side of the crank web there is a crank case air sealing plate, which is ground to fit the crank shaft, and is held in position against the machined face of the bearing housing by four springs. No packing of any kind is used and a scavenge air pressure of approximately 4 lb. per square inch is obtained. It is of interest to note that with a view to marine work the crank shaft has been designed to conform with Lloyd's requirements, and we understand that Lloyd's approval has been obtained for the patented construction, by which the bottom end roller bearing is secured and aligned on the crank pin. In the past ball or roller bearings used on crank pins have generally had to be divided diametrically, in order to enable them to be placed in position on the crank pin, for in most cases the internal diameter of the inner race was too small to admit of the unbroken ring being threaded over the crank shaft and the crank webs. According to the method employed in the Richards engine a roller bearing is employed which is undivided and has an internal race diameter large enough to permit of it passing over the shaft and webs. Means are provided for clamping the inner race, and, therefore, the whole bearing in its true position in the crank pin. The arrangement is illustrated in Figs. 1 and 5, and in Fig. 3 we reproduce a photograph of the bottom end bearing and the internal clamping device before it is put into position on the shaft. The main components of the clamping device are two expanding coned sleeves A and B—see Fig. 1—which fill up the space between the crank pin and the inner bearing race. As shown in Fig. 3, each sleeve is provided with longitudinal slits similar to those used in a collet, which allow it to expand. The thrust of the two sleeves is taken by a ring C, which is made in halves, fastened together with tangential screws, and fits the crank pin. At the opposite side of the crank pin there is a similar screwed nut D, also in halves, which engages with a thread cut on an extended portion of the inner sleeve. When this nut is placed in position and the two halves secured together by its screws, it is turned in an outward direction, and by thrusting against the adjacent crank cheek the two sleeves are tightly engaged and expanded so as to fix and centre the inner roller race in its position on the crank pin. While this is being done the outer sleeve B is prevented from moving in an endwise manner by the thrust ring C. A further refinement is the provision of bevelled oil throwers on both the nut D and the ring C, which, in conjunction with annular cover plates secured to the sides of the outer roller race—see Fig. 5—serve to keep oil in the bearing. Lubricating oil is fed to the bottom end bearing by means of a banjo plate attached to the crank web, and supplied with oil from a connection on the top of the main bearing cap. The crank pin is drilled through longitudinally and radially, and oil finds its way through it by a drilled passage to an annular space left between the end of the inner sleeve and the thrust ring which forms an oil reservoir. There is thus

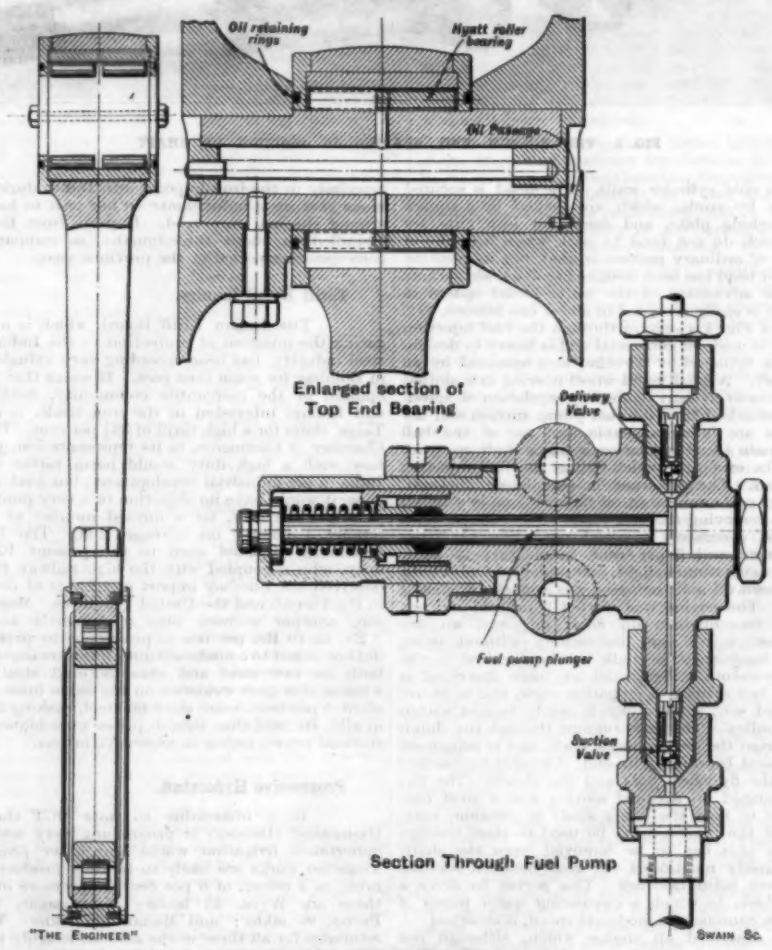


FIG. 4—SOME ENGINE DETAILS

a free passage from this point to the rollers between the races, and oil is carried forward by centrifugal force, efficiently lubricating the bearing. Referring to the illustration—Fig. 3—it will be noted that a full roller bearing of the Hoffmann type is used. The connecting-rod is a solid steel forging with a specially designed top end. Fig. 4 shows the rod itself and an enlarged section through the top end bearing showing the pin fastening and the lubricating arrangements. In this case a Hyatt roller bearing of ample width is employed, for the slight resiliency given by the spiral rollers is useful, giving very quiet running. End plates with a packing ring serve to retain the oil in the bearing, which when once charged with lubricant practically runs in an oil bath. The oil is supplied from a mechanical lubricator driven from the fuel pump by a link and finds its way through the hollow piston pin to the bearing. In practice, owing to the large amount held in the bearing, very little oil, we understand, serves to lubricate both the cylinder walls and the top end bearing. Provision is made for charging the top end bearing with lubricant, which operation may be carried out with the engine either running or standing.

Brief reference may be made to the design of the piston, which is furnished with five piston rings and one oil wiper ring. It is of the usual shape, the top being sloped towards the exhaust ports. One feature is its great length in proportion to its diameter. By making a long piston it was possible to place the piston pin low down, thus precluding any undue heating of the oil in the top bearing. The liner is ground and polished, which gives a fine surface as soon as the engine is run. Careful consideration was given to the design of the cylinder head, in order to obviate heat stresses. It will be noted that the head forms the lower portion of the combustion space, so that it is not necessary to utilise any part of the cylinder space as a mixing and combustion chamber. With the design of head shown the air becomes mixed with the fuel as it is forced by the compression pressure into the head, and it is again mixed after ignition of the charge, when it passes the neck in the head and emerges into the cylinder proper. The shape of the head gives turbulence and prevents contact of the

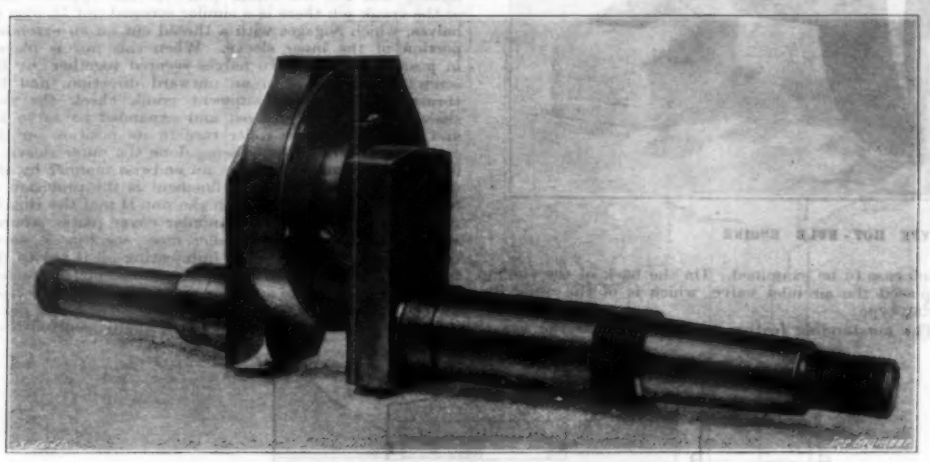


FIG. 5.—THE BOTTOM END BEARING IN POSITION ON SHAFT

fuel with the cold cylinder walls. The head is secured to the collar by studs, which are locked by a square collar and locking plate, and deep cast iron nuts are employed which do not tend to stick when heated. A spray nozzle of ordinary pattern is used, but its position in the cylinder head has been designed to avoid air pockets and take full advantage of the water-cooled spaces in the head. It is easily removed in about one minute.

We show in Fig. 4 a section through the fuel injection pump, which is made in gun-metal and is heavy in design. This pump is actuated by a rocker arm operated by an excentric shaft. A small hand-wheel moving in a slotted quadrant serves to give any temporary regulation of speed. It may be remarked that the fuel pump suction and delivery valves are interchangeable and are of the ball type. For main speed regulation a crank shaft governor controlling the excentric which drives the fuel injection pump is used. The governor is completely enclosed, and the main parts run in an oil bath. Complete access is gained by removing the end plate. For running with direct-coupled generators a speed regulation of 3 per cent. permanent and 6 per cent. momentary is used. We saw the engine running light, and under load, also with the load thrown off and the speed was remarkably steady throughout. The engine was started from cold and put on load in four minutes on Solar oil, and we are informed that it will run indefinitely without using the heating lamp once the bulb has been raised to the desired temperature. The model we have described is intended for belt driving or irrigation work, and is, therefore, provided with a plate clutch neatly housed within the driving pulley. The shaft running through the clutch is separate from the engine crank shaft, and is supported by an outboard bearing at its end. A conical connecting piece joins the fly-wheel boss and the clutch. The fly-wheel is mounted on a coned seating and a steel nut, which serves to hold the crank shaft in position, may, on turning it the reverse way, be used to start the fly-wheel when this has to be removed from the shaft. We have already mentioned the gear between number two and three main bearings. This serves to drive a horizontal shaft, to which a circulating water pump of the gear type, running at a moderate speed, is attached.

We have described an engine which, although not large in power, presents some novel features of design. In it an attempt has been made to overcome bearing and running defects, which may frequently lead to breakdowns in service. S. Richards and Co., Limited, are well known in East Anglia as builders of wooden and steel drifters and fishing vessels. The firm has seen the transition from sail to steam power, and has built notable vessels of both kinds. The motor-driven craft is steadily taking its place in our fishing fleets, and we welcome a sincere attempt to evolve an internal combustion engine fitted in every way for the arduous duties of such a service.

Indian Engineering Notes.

(From a Correspondent.)

Iron Imports.

Imports of iron and steel into India during the six months from April to September, 1923, amounted in value to 7.86 crores of rupees, as against 8.77 crores in the corresponding period of 1922. The value of beams, pillars, girders and bridgework imported amounted to 55 lakhs of rupees, as against 68 lakhs in the corresponding period of the previous year. The share of the United Kingdom was 35 lakhs of rupees. Bolts and nuts were responsible for 14 lakhs, as against 20 lakhs of the previous year; hoops and strips for 25 lakhs, as against 21 lakhs; nails, rivets and washers for 28 lakhs, as against 30 lakhs; cast pipes and fittings for 16 lakhs, as against 29 lakhs; galvanised sheets and plates for 2.25 crores, as against 1.65 crores; tinned plates for 88 lakhs, as against 89 lakhs; plates not galvanised or tinned for 90 lakhs, as against 91 lakhs; wrought tubes, pipes and fittings for 49 lakhs, as against 76 lakhs; wire nails and rope for 32 lakhs, as against 30 lakhs; steel bars and channels for 93 lakhs, as against 1.48 crores. During this period the United Kingdom has scored very well, having increased her share from about 4.3 crores of rupees to about 5 crores, the increase under galvanised sheets and plates being specially remarkable. The imports from Germany, as was to be expected on account of the Ruhr situation, have declined from about 1 crore to one-third of it. Considering that Germany had largely extended her trade, especially in the iron imports into India, during the previous year, it is unfortunate on her part to have lost the ground she had recovered. Imports from Belgium also dwindled to about three-fourths, as compared with a corresponding period of the previous year.

Tariff Board Inquiry.

THE Indian Tariff Board, which is now investigating the question of protection to the Indian iron and steel industry, has been recording very valuable evidence in Bombay for some time past. It seems that the general opinion of the mercantile community, both European and Indian, interested in the iron trade, is against the Tatas' claim for a high tariff of 33⅓ per cent. The Bombay Chamber of Commerce, in its representation, pointed out how such a high duty would harm rather than assist India in her industrial development; but that, at the same time, it would have no objection to a very limited amount of protection, say, for a limited number of years, preferably a bounty on tonnage sold. The Indian iron merchants objected even to the present 10 per cent. duty, which, coupled with the high railway freights, has deprived the Bombay import merchants of their markets in the Punjab and the United Provinces. Major Richardson, another witness, also recommends a bounty of 5 Rs. to 10 Rs. per ton in preference to protection, but did not object to a moderate duty if it were imposed equally both on raw steel and manufactured steel. Another witness also gave evidence on the same lines, and would allow 5 per cent. more duty on steel, making 50 per cent. in all. He said that British prices were higher than continental prices, owing to expensive labour.

Progressive Hyderabad.

It is interesting to note that the State of Hyderabad (Deccan) is progressing very well, and has undertaken irrigation works and other projects. The irrigation works are likely to be fully productive, and to bring in a return of 6 per cent. The more important of these are Wyra, 25 lakhs; Nizamsagar, 305 lakhs; Purna, 90 lakhs; and Manair, 35 lakhs. The present estimates for all these works amount roughly to 7½ crores. The other projects are hydro-electric power schemes, which are expected to be more remunerative than the first, and which will require an expenditure of 4 crores. Besides these projects, protective works are undertaken to protect the areas served by them from famine, although these works are not likely to bring in a return of 6 per cent. Out of these projects, the Irrigation Department is particularly keen on starting as soon as possible and completing within a few years, the Nizamsagar project, which will cost over 3 crores, with an anticipated return of 12.5 per cent.; the Devanoor project, which will bring in a return of nearly 14 per cent. on about 1½ crores; the Purna project, which is expected to yield a return of 6¼ per cent. on 90 lakhs; and the Tungabadhra project, which will protect the Raichur district from famine. Some projects, such as Royanpally, Palaivete, including Nizamsagar project, have already been commenced, and are expected to require for the next year a total expenditure of 40 lakhs. But by that time Royanpally and some others will have been completed, and will relieve a grant of 16 lakhs a year from the ordinary revenue and 2½ lakhs from capital funds.

Hydro-electricity for Bombay.

The Bombay Municipality is installing an electric plant and machinery for the purpose of pumping at the Love Grove pumping station, as a temporary expedient until such time as the new drainage scheme is put into operation. The plant had been ordered for the Tansa completion works, but for the present is being thus used, especially because a substitution of electricity for steam power is now a profitable proposition. The power is to be supplied by the Tata Company at a rate of 0.725 annas per unit, and on this account the same type of plant as has been standardised by that company is found advantageous. It is therefore proposed that the order for the municipal requirements in this connection should be placed with the Metropolitan-Vickers Electric Company, the quotations of which are as follows:—Two 500 horse-power alternating-current slip-ring type motors running at a speed of 375 revolutions per minute, three phase, 50 periods, 2200 volts, suitable for direct coupling for centrifugal pumps; two controlling gears for these motors, complete with one switch pillar and starter; and two 500 kilovolt-ampère transformers, three-phase, 22,000–2000 volts; price f.o.b. Manchester, £2668. The estimates of the cost of installing the electric drive have also been prepared, and are as follows:—

	Rs.
Two 500 horse-power 2000-volt motors	30,770
Two controlling gears	6,000
Two transformers	18,000
Cost of electrical cables fitting switch-gear	4,000
Cost of high-tension equipment	1,000
Alterations to pump outlets	5,000
Installation for valve chamber outside engine-house	4,000
Foundation for pumps and motor	5,000
Dismantling old plant	9,000
Concrete work	2,500
Tiles for floor	2,000
Alterations to sewers	7,000
New bed-plates for pumps and motors	4,500
Cost of erection	10,000
Contingencies at 10 per cent.	4,900
Total	1,13,670

The municipality has given its sanction for carrying out the scheme, and has authorised the Commissioner to incur the necessary expenditure in that connection.

KELVIN CENTENARY.

LORD KELVIN was born on June 26th, 1824, and arrangements are being made by a committee convened by the Royal Society to celebrate the centenary of his birth in a fitting manner.

The Committee is composed as follows:—

Sir Richard Glazebrook, K.C.B., F.R.S. (Chairman).
Dr. F. O. Bower, F.R.S. (The Royal Society of Edinburgh).
Mr. W. R. Cooper, M.A. (The Physical Society).
Sir John Dewrance, K.B.E. (The Institution of Mechanical Engineers).
Mr. D. N. Dunlop (Hon. Secretary),
Mr. F. Gill, O.B.E. (The Institution of Electrical Engineers).
Sir Donald MacAlister, Bart. (Vice-Chancellor of Glasgow University).
Sir Charles Morgan (The Institution of Civil Engineers).
His Grace the Duke of Northumberland (The Institution of Naval Architects).
Dr. E. C. Pearce (Vice-Chancellor of Cambridge University).
Dr. Alexander Russell (The Institution of Electrical Engineers).
Mr. F. E. Smith, F.R.S. (The Royal Society).

A large number of Dominion, American and foreign men of science and engineers will be attending conferences at the British Empire Exhibition this summer, and July 10th and 11th have been selected as convenient dates for the Kelvin Centenary Celebrations. They will include a meeting for the receipt of addresses from delegates, at which Sir J. J. Thomson will deliver a Memorial Oration, and a dinner at which the Rt. Hon. Earl Balfour has kindly promised to preside. There will also be an Exhibition of Kelvin apparatus, and it is hoped to issue a Memorial Volume containing the addresses and speeches delivered, with some account of the apparatus exhibited. It is hoped that the President and Council of the Royal Society will receive the delegates during the celebrations at the rooms of the Society in Burlington House.

AN IMPORTANT CONTRACT.—The contract for the Avonmouth Dock extension, at Bristol, has been awarded to Sir William Arrol and Co., Limited, of London and Glasgow. The contract sum is given as being £554,000.

Railway Matters.

DURING the last ten years the number of passengers using the Metropolitan District station at Victoria has increased from seventeen to twenty four millions a year.

A MESSAGE from Moscow says that the Commissariat of Ways and Communications is starting work on the reorganisation of the Tran-Siberian Railway. The opening of the direct route Moscow-Vladivostok *vid* Chita and Khaborovski is fixed for February 1st.

THE railway statistics of the Ministry of Transport contain particulars of the tonnage, receipts and receipts per ton-mile at each mile up to 50 miles and in mileage groups beyond that distance of different commodities. The statistics for October, for instance, contain these particulars—for the four weeks ended September 9th—of the deals, battens and boards, pitwood and round timber.

ALTHOUGH, as related in this column on November 23rd last, the West Riding County Council does not see its way to support the Longridge-Hellifield Railway, 24 miles in length, along the Hodder Valley, there is, in the opinion of the engineer, now every prospect of the line being built. Three local authorities have agreed to subscribe £1000 per mile, and the remaining fourth is regarded as certain.

THE board of directors of the South Indian Railway has appointed Mr. Alexander Muirhead, C.I.E., to succeed Sir Henry Kimber on the board. Mr. Muirhead has been connected with the South Indian since 1911, when he had already had nearly thirty years' experience on three other railways there. His appointment in 1911 was to succeed the late Mr. Neville Priestley as Agent, and on Mr. Priestley's death three years ago, Mr. Muirhead came home to take his place as managing director.

THE collision at Crewe on the 9th inst., mentioned in this column last week, was not the only serious accident that day. When on the down gradient approaching Rowsley on the former Midland system, a train of 60 wagons became divided, and the rear ran into the leading portion when the engine came to a stand. Both lines were blocked for 13 hours. This delay and the damage to wagons and their contents would pay for the equipment of a continuous brake to many wagons, which is the only remedy against this class of accident.

THE first step towards amalgamation of the two stations at Victoria of the Southern Railway was taken some months ago when a superintendent, in charge of both stations, was appointed. Now the dividing wall is to be taken down, and already it has been pierced so that passengers can now pass from one station to another without going into the station yard. Later there will be inter-connections at the approaches to the stations, so that they may be used in common by trains to and from either of the two amalgamated systems, and the platforms in the South-Eastern and Chatham Station may be lengthened. In this connection it may be noted that in the Bill now being promoted by the Southern Railway, powers are sought to repeal so much of the London, Chatham and Dover Railway Act, 1863, and the South-Eastern and London, Chatham and Dover Railways Act, 1905, as prohibits the making of an exit or entry for vehicles to or from Victoria Railway Station from or to Eccleston Bridge and Belgrave-road.

THOSE who take an interest in the affairs of the United States will have noticed that, from time to time, laws passed by Congress are taken, by parties concerned, to the United States Supreme Court for determination as to whether certain parts are constitutional. This was, for instance, done by the railway companies when, in September, 1916, President Wilson got Congress to pass a law constituting an eight-hours' day for trainmen. It has now also been done by the railway companies with respect to sub-section (5) of the new section 15*a* ordered by the Transportation Act, 1920, to be added to the Interstate Commerce Act. This was, in a sense, a rider to the provision that the companies were to be entitled to a fair return of 5½ or 6 per cent., and laid down that if, under the Act of 1920, any company received more than 6 per cent., one half of such excess was to be placed to reserve by the company and the other half to be placed in a contingent fund to be administered by the Commission "in furtherance of the public interest in railway transportation." This, it was claimed by the companies, was unconstitutional, but judgment to the contrary was given by the Supreme Court on the 7th inst.

WHEN signal-boxes are closed at times when adjoining boxes are open, the block wires are switched out of the closed box, and so A and C communicate direct when B is shut. In three-wire block instruments, when B goes on duty and turns his switch from "out" to "in," the indications of the A–C instruments at once are repeated on his, and he can see the condition of his sections. In the one-wire instruments mentioned in our leading article of October 19th, the indications are not so repeated; the needles stand at normal or "line closed." It has been suggested to us that this is inconvenient; but, in fact, it is not so, as the instructions are that the man must ascertain by telephone the condition of the sections, and set his instruments to suit. Should, however, he have no telephone, the man, before switching in, must turn his indicators to "train on line" and plunge. This act simply rings his own bells, and shows that his instruments are in order. He then turns his switch to "in" and plunges the "switching in" bell signal. That is repeated in the adjoining boxes, and the indicator there is turned to "train on line." If A had already signalled "train on line" to C, or C had done so to A, the signal from B is simply repeated. If, however, no train is in the section and the indication should be at "line closed," the signalman at the box in advance gives the train-out-of-section block signal to B, and the latter gives it to the box in the rear, and the indicator goes to "line closed." Should "line clear" be the actual signal the man in the rear at once would give the train-entering-section signal, which B must immediately pass on to the box in advance. The whole arrangement is quite simple and safe; moreover, it secures definite proof that the instruments between A, B and C are in working order.

Notes and Memoranda.

THE new gun evolved by the United States Army experts is said to be the most powerful built since the war. It is of 14in. bore and will send a 1560 lb. projectile 23 miles. The total weight is 700,000 lb.

THE transmission line of the Southern California Edison Company has been altered to withstand 220,000 volts instead of the original 150,000 volts, without cutting off the current. The towers were all raised in height by 10ft., and each string of insulators was increased from eleven to thirteen in series.

THERE have been investigated and mapped by the Mines Department 46 peat bogs in Ontario, 27 in Quebec, 7 in Manitoba, and 27 in the Maritime Provinces, comprising a total area of 228,000 acres. Seven bogs within a shipping distance of Toronto are estimated to be capable of producing 26,500,000 tons of peat.

IT is proposed that some further work should be done in utilising the volcanic energy of Italy on much the same lines as the plants at Lardarello and Volterra in Tuscany. The districts round Vesuvius and Etna, besides the islands of Lipari, are being studied with the idea of utilising the naturally produced steam for power purposes.

A FRENCH company has placed on the market a non-poisonous reddish-brown paint, the base of which consists of titanic oxide. It is claimed that a given weight of the new paint will cover over twice the area of steel work that red lead will do. The colour of the new paint remains brilliant even at a temperature of 100 deg. Cent.

IN the course of a paper on "Friction and Lubrication," read before the Cleveland Institution of Engineers, Mr. D. Sillars said that, except for a few special purposes, all running parts of machinery could be lubricated by suitable mixtures of American and Russian petroleum, either alone or blended with rape and cotton-seed oil. With these four stocks, oils to any specified flash point, viscosity, specific gravity, acidity, saponifiable matter, volatility or emulsifity could be prepared. Their success as lubricants would depend on the proportions used and on the origin of the stock oils.

LIGNITE deposits have been discovered not far from Shrinagar, Kashmir, at an elevation of 6000ft. to 7000ft. They appear to exist in continuous seams of from 2ft. 6in. to about 6ft. or 8ft. thick. The few square miles already surveyed show reserves of some 30 to 40 million tons. An analysis made by the Mineral and Geological Survey shows that the fuel contains 15 per cent. of moisture, 30 per cent. of ash, 28 per cent. of volatile matter, and 27 per cent. of fixed carbon. Its heating value is from 4034 to 2274 calories, and its evaporative power from 7.51 to 4.23. The moisture may be reduced to less than 10 per cent. by stacking the lignite in the sun.

THE use of waters containing dissolved methane in enclosed hot-water and steam-heating systems presents dangers which heretofore may not have been considered. When heated, water that contains dissolved methane liberates the gas on account of the reduced solubility of gases at elevated temperatures. If such waters are used in enclosed circulating heating systems, there would soon accumulate large quantities of methane in the upper parts of the system, over the water. Unless this gas is vented off, additional fire risks are produced thereby. In fact, when explosions occur in heating systems, the greater damage may be due to the ignition of the methane.

ONE of the notable changes in machine shop practice and equipment is, according to the *American Machinist*, the increasing use of washing machines for cleaning the dirt and grease from the work. While this is perhaps more frequently used after the parts are finished, and just before they go to assembly, the washing machine is also finding its place between operations to an increasing extent. In place of the old soda kettle, which frequently became a nuisance and a menace, and of the dangerous petrol bath, there is now the continuous steam washer, in which the dirty work goes in at one end and comes out at the other—clean. While it may perhaps be classed as a minor improvement, it shows one of the tendencies of the times in modern manufacturing methods.

FURFURAL, the aldehyde of furfuran, has several important and physical properties, according to the *Building News*, which render it greatly superior to the dangerous substances commonly used as paint removers. It may be prepared by placing corn cobs in an autoclave and digesting for two hours with steam at about 135 lb. pressure. The furfural formed is then blown off by steam, condensed, and separated from water by distillation—the boiling point of furfural being the same as that of turpentine. The average yield is about 6 per cent. Furfural is not, it is said, objectionable to work with, since it has a rather pleasant smell. It has only one disadvantage—that of forming drops on the surface of the work, but it is readily removed by the addition of about 20 per cent. of solvent naphtha.

ADDRESSING the annual meeting of the American Society of Mechanical Engineers, Mr. John R. Freeman said:—"In a broad review and for a round figure, we may regard the general station cost to-day, hydro or steam, as 1 cent per kilowatt-hour. One cent. per kilowatt-hour is equivalent to 22.36 dollars per horse-power year for 10-hour power drawn on 300 working days. Although I have no recent or broadly collected figures, and freight rates on fuel cause wide differences in cost, it appears probable that few textile factories in New England with the best large reciprocating engines are now obtaining their power for less than, say, 30 dollars per horse-power year, which would be about equivalent to 1.5 cent per kilowatt-hour for nine working hours, when all costs are reckoned in. I am told that the best large stations to-day can cut this figure in half, for cost at bus-bar. It is estimated that with units of 30,000 kilovolt-amperes—steam at 600 lb., coal at about 5 dollars—the cost at bus-bar can be brought to 6 mills per kilowatt-hour under a favourable load factor, and there are a few great hydro stations at localities that are few and far between where it is reported power can be put on the bus-bar at 3 mills per kilowatt-hour, including all proper charges." Mr. Freeman went on to suggest that fifty years hence the cost to the consumer in New England would not be less than 1.25 cent per unit.

Miscellanea.

THE annual consumption of powdered coal in the United States is about 12,000,000 tons.

NEW regulations governing the grant of patents in Russia are now under consideration.

A PLANT for the production of patent fuel, at the rate of 50 tons per hour, is to be put up at Hamilton, Ontario.

THE City Council of Leicester is considering the rebuilding of a large part of the city at a cost of £4,000,000.

THE Armourers' and Braziers' Company has decided to found a research fellowship in metallurgy of the value of £500 per annum for five years.

THE Snowdon Colliery, near Dover, which has been practically closed down for some time, has been purchased by Pearson and Dorman Long, Limited.

GRAIN handled by the port of Montreal in 1923 totalled 120,013,935 bushels, the largest amount shipped through any port in North America during the year.

THE plant of the Plymouth electricity works is being extended by the addition of a 6000-kilowatt generating set. Two more boilers have also been added.

IT is reported from Paris that Senor Pescara made a flight, in his helicopter, last week of over eight minutes, during which he covered a distance of about 5½ furlongs.

THE Sugarloaf-Rubicon electricity supply scheme, Victoria, will probably be completed by 1928, and will then have involved an expenditure of nearly a million sterling.

AS a result of the Fordney Tariff, in America, the exports of steel from Sheffield to the United States fell last year to 1,897,701 dollars, as compared with 2,373,248 dollars in 1922.

A SCHEME for the sale of gas engines on hire-purchase terms has been revived by the Birmingham Corporation. The engine is supplied at the maker's price, and payments are spread over a period of three years.

ACCORDING to the *Birmingham Post*, a Sheffield firm has evolved a gold alloy which has the appearance of platinum, and can only be discovered by an acid test. Its price is about one-third greater than gold.

A NEW trade route will shortly be opened between Teheran, and the Persian Gulf, *vid* Kum, Sultanabad, Khurramabad, Shushter, and Mohammerah. The work of making the road possible for motor traffic along this route has already begun.

IT is expected that the new port plant of the Hollinger Consolidated Gold Mines, Northern Ontario, will be ready for operation next August. The mill, which is now treating some 4400 tons of ore per day, will, when the new power is available, be increased to a daily capacity of 8000 tons.

AMONG the articles in the new mining supplement of *Canada* there is a description of the Hollinger gold mine in Northern Ontario, which is claimed to be the second largest gold producer in the world. It is said that the mine is capable of producing 500,000,000 dollars of gold from ore above the 5000ft. level.

ACCORDING to a recent report on the industries of the Punjab, coal from Bengal costs Rs. 25 a ton on an average, and the province looks to hydro-electric power to meet this disadvantage. The Punjab is fairly well served with railways, though more are required; the provision of tramways for the efficient marketing of agricultural produce is being considered.

IN the official Mining News Letter issued by the offices of the High Commissioner for Canada, it is reported by Mr. G. S. Hume, of the Canadian Geological Survey, that a new well was "brought in" last summer in Kent County, Ontario, the well being 3560ft. deep, with an estimated initial capacity of 200 barrels a day. This oil was struck in the Trenton formation.

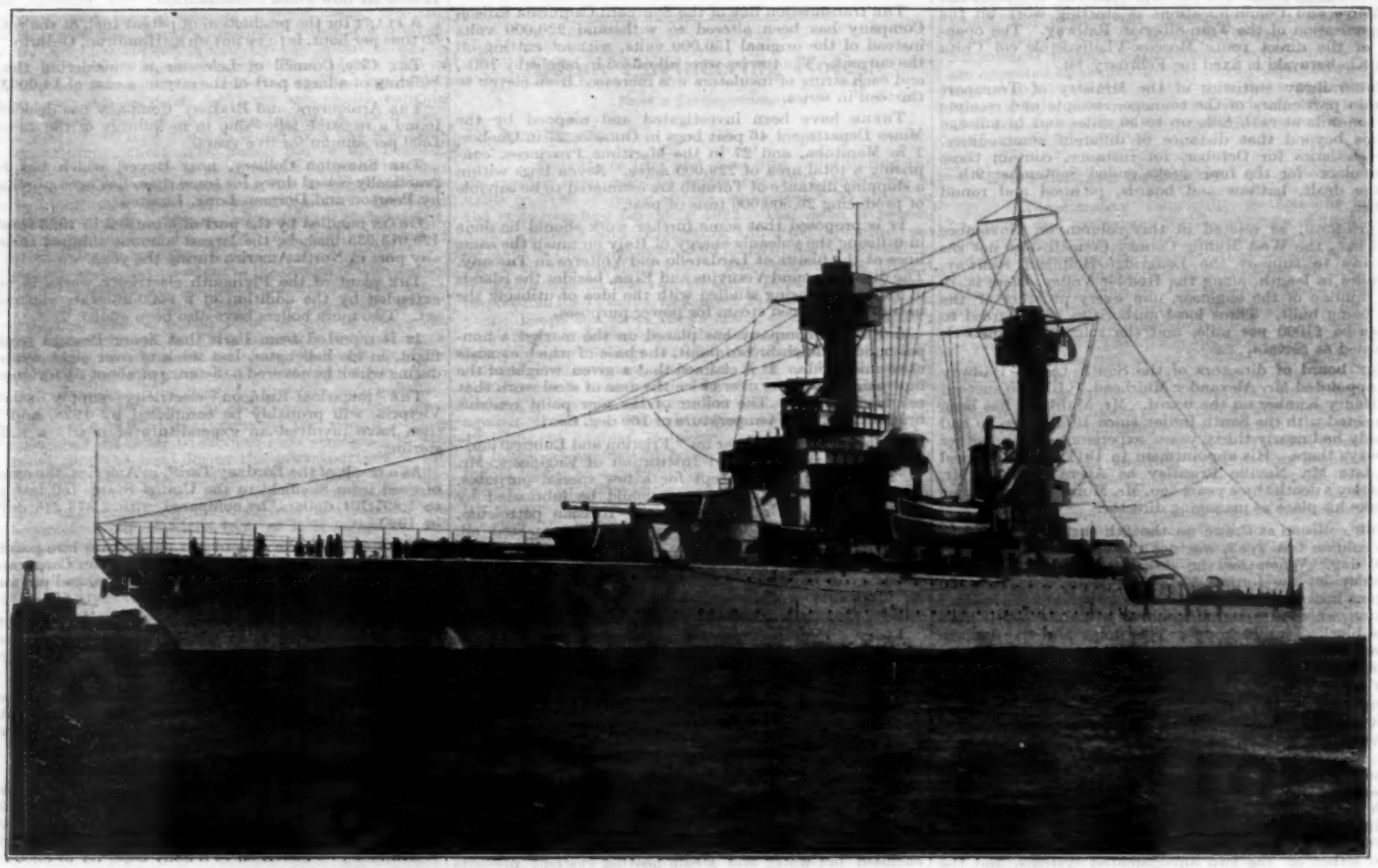
THE action of the Toronto City Council last year in refusing to accept the lowest tender made by a British company for a large order for cast iron water pipes and awarding the contract at a compromise price to a local tenderer whose original quotation was higher, was discussed at a meeting of the Toronto Board of Trade on Monday last. The meeting ultimately passed a resolution condemning the City Council's action and declaring it "detrimental to the City's prestige and to our credit at home and abroad."

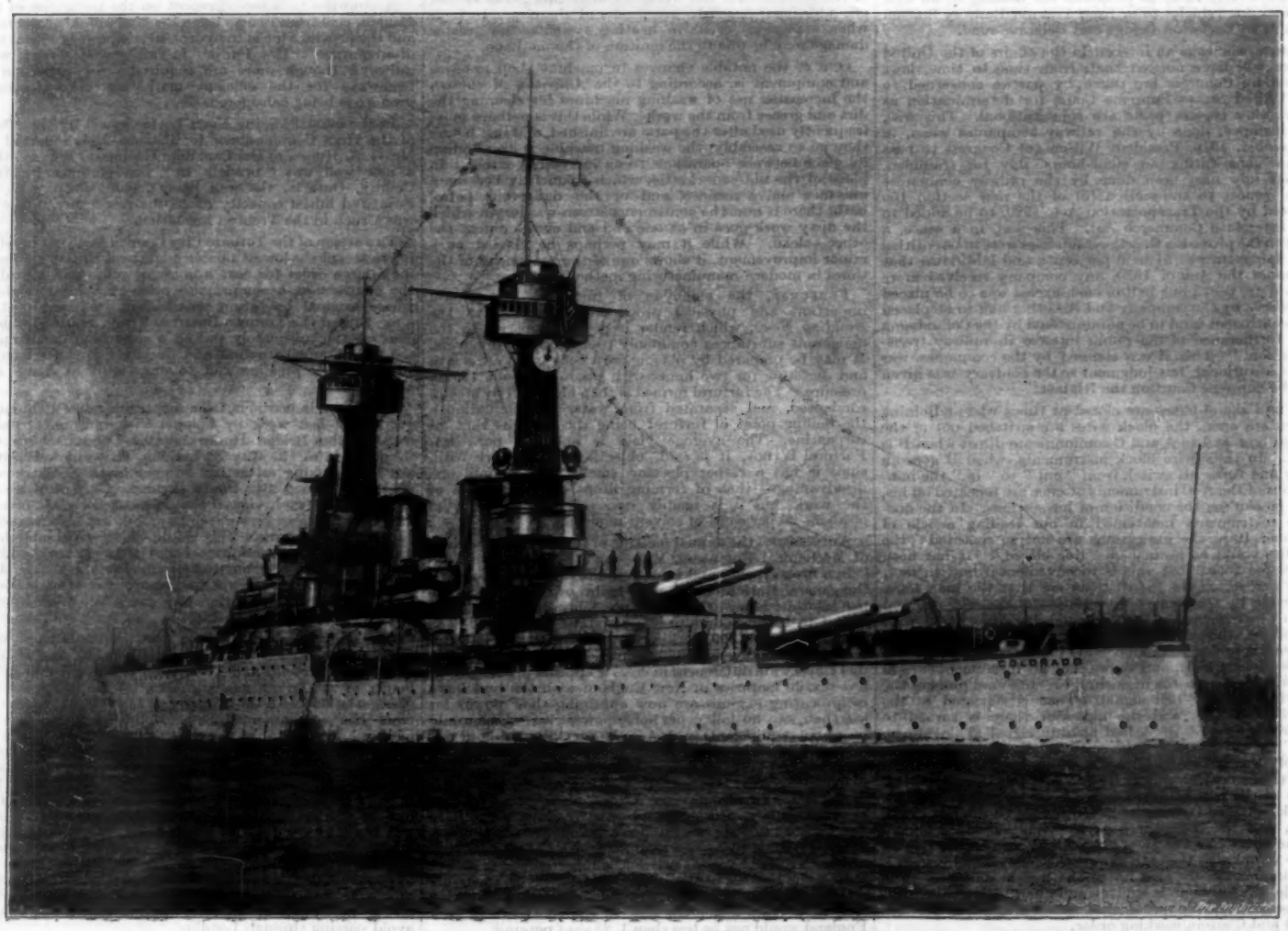
THERE are indications, from a speech made on Thursday evening of last week by Colonel Vickers Dunfee, chairman of the Bridge House Estates Committee of the Corporation of the City of London, that the authorities are again taking an active interest in the construction of the proposed St. Paul's Bridge. The Ministry of Transport, he said, viewed the project with great favour, and was willing to give not only moral, but also financial, support to the work. This would be very valuable help as, although the committee had the funds for building the bridge itself, the construction of arterial roads, leading to and from the bridge, was a necessary part of the scheme, and in this latter direction any funds provided by the Ministry would be invaluable.

FOR some considerable time past proposals have been made for constructing a road tunnel below the Thames between Gravesend and Tilbury on the south and north banks of the river near its mouth. As the outcome of negotiations with the Ministry of Transport the Government has now assumed responsibility for the expense incurred in obtaining a survey of the ground and in the preparation of plans and estimates for the tunnel. Sir Maurice Fitzmaurice has, it is announced, been appointed to carry out this preliminary work. He has already had experience of tunnelling below the Thames, for he was engaged upon the Blackwall Tunnel, and was the engineer for the Rotherhithe Tunnel. The new tunnel, according to those urging its construction, would not only provide a considerable volume of work for the unemployed but would provide an important and useful link whereby traffic between Kent and the districts on the north side of the river would be in a position to avoid passing through London.

THE UNITED STATES BATTLESHIP COLORADO

(For description see page 90)





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Contents.

THE ENGINEER, January 25th, 1924.

	PAGE
A SEVEN-DAY JOURNAL	85
THE TURBINES AT RAANAASFOSS POWER STATION, NORWAY. (Illus.)	86
PNEUMATIC GRAIN ELEVATORS. No. III. (Illus.)	89
THE UNITED STATES BATTLESHIP COLORADO. (Illus.)	90
A ROLLER BEARING OIL ENGINE. (Illus.)	92
INDIAN ENGINEERING NOTES	94
THE KELVIN CENTENARY	94
RAILWAY MATTERS	95
NOTES AND MEMORANDA	95
MISCELLANEA	95
LEADING ARTICLES—	
The Railway Strike	97
Methods of Manufacture	98
LITERATURE	98
RECENT PROGRESS IN GEARS AND GEAR CUTTING	99
OBITUARY—	
John Walter Brooke	99
SIXTY YEARS AGO	99
A VERY LARGE CONDENSER. (Illus.)	101
A LIGHT AERIAL ROPE CONVEYOR. (Illus.)	101
TESTS OF A REVERSING DRIVE FOR PLANING MACHINES	101
LLOYD'S REGISTER ANNUAL SUMMARY	102
LETTERS TO THE EDITOR—	
Railway Electrification	103
Marine Hot-bulb Engines and Crank Case Compression	103
Powdered Fuel	103
Bogus Situation Advertisements	104
ELECTRIC LIFTS. (Illus.)	104
PROVINCIAL LETTERS—	
The Midlands and Staffordshire	105
Lancashire	105
Sheffield	106
North of England	106
Scotland	107
Wales and Adjoining Counties	107
CURRENT PRICES FOR METALS AND FUELS	108
FRENCH ENGINEERING NOTES	109
BRITISH PATENT SPECIFICATIONS. (Illus.)	109
FORTHCOMING ENGAGEMENTS	110
PERSONAL AND BUSINESS ANNOUNCEMENTS	110
CONTRACTS	110
PARAGRAPHS—	
Double-inlet Drainage Pump	103
Institute of Transport	110

THE ENGINEER.

JANUARY 25, 1924.

The Railway Strike.

ONCE more a very small section of the public has, for the furtherance of its own ends, brought inconvenience, discomfort and distress to the whole community and caused grave injury to the trades and industries of the country. A railway strike is not comparable with ordinary industrial strikes. Its effects are far more serious, because far more widespread. By stopping communication, it closes the arteries of commerce of all kinds, and if pursued to its ultimate length may even cause famine and pestilence. Were it not an accomplished fact, it would reasonably be held to be inconceivable that a trade union, numbering no more than a few thousand men, should be able to place between forty and fifty millions of persons in a position of serious inconvenience, injure the commerce of the land, and bring the nation within sight of danger to its health and well-being. It is still more inconceivable when we observe that less than fifty men would be seriously affected by the conditions against which the strike has been invoked, and that the greater body of railway workers as represented by the National Union, and the whole mass of labour of the country, as represented by the General Council of the Trades Union Congress, lend no support to the action of the small society, and even condemn it in round terms. One may well ask what is wrong with the world when such things can be tolerated, and must stand astonished at the total failure of the machinery which was designed with much care to prevent such signal catastrophes. In face of such facts, we may well despair that any device which the mind of man can imagine for the peaceful settlement of industrial differences will ever be successful. It is, perhaps, one of the most astounding results of progress that the dependence of the whole community on a few specialised workers is so absolute that those workers are placed in a position of power over the welfare and prosperity of a whole nation.

To comprehend the strike we must throw our minds back to that August in 1917 when the Associated Society of Railway Engineers and Firemen took advantage of the strain under which the country was labouring to exact from the Government a promise to afford railwaymen, within one month after the cessation of hostilities, a chance of preferring a demand for a shorter working day. The Government, which was still in control of the railways, was held rigidly to this promise, and on December 6th, 1918, without consulting the companies as to the wisdom or the effect of that course, it reduced the railway day from ten hours to eight. For that error the country has had to pay ever since in excessive rates. With the object of removing some of the anomalies which followed automatically from it, and with the hope of reducing expenditure by something like four million pounds per year, the companies made proposals which eventually came before the National Wages Board in November last. That Board, after hearing the arguments of both sides, decided that in the majority of cases no radical changes could be made. It found, however, that in the case of enginemen, the old basis of 150 miles as the equivalent of a working day—ten hours at 15 miles per hour—should be restored, and that the new basis of 120 miles, which had been accepted automatically when the working day was reduced from ten hours to eight hours, should be abandoned. It is agreed that the "findings" of the National Wages Board are not binding in the sense that those of an Arbitration Tribunal are, but they are generally regarded as morally binding, and, in fact, in this case we find that the National Union of Railwaymen has loyally accepted them. Mr. Bromley, however, despite the fact that he was a signatory to the "findings," went straight from the Council room and ballotted his men on their acceptance or rejection. We believe that the terms in which the ballot papers were drawn up have not been revealed, and we are unable to say in how far they may have affected the voting. We do know, however, that Mr. Bromley had it in his power, and would have been within his rights, in recommending acceptance; even more, he might have held that his own signature was sufficient, and that no ballot was required. He preferred to take the opposite course, and the evidence to our mind clearly indicates that he himself, although he appeals to the ballot, is opposed to acceptance of the terms, and that he, himself, is morally and actually responsible for the course taken by his union. In seeking to understand his action, we cannot dispel from our minds the feeling that it is not wholly inspired by a desire to retain for his men, of whom according to a report made by the railway companies only a few are seriously affected, a rate of pay which may justly be regarded as excessive, but that the rivalry which is well known to exist between his union and the N.U.R. influenced him in no small measure. With motives, however, we are less concerned than with facts, and the facts appear to be that out of a total number of drivers, amounting to 36,000, only 2400 receive payment on the mileage basis, to which we have alluded above, that the average reduction of wages of these 2400 will amount to 7s. 5d. per week, and that only 48, of whom not all are members of the Associated Society, will have to submit to the maximum reduction of 22s. 6d. per week, leaving them, even then, £6 12s. 5d. per week each on the average. These figures have been broadly circulated by the railway companies for some days past, and as no denial is forthcoming, we may presume that they are not challenged. Furthermore, the companies have stated quite definitely that they are, as usual, perfectly ready to consider any cases of exceptional hardship, and that the fear of wholesale dismissals and degradings is without foundation. Indeed, the companies have gone so far on the road towards conciliation that they have promised that there shall be no dismissals at all, and that negotiations as to hard cases shall be immediately considered. This offer, as a result of the efforts of the General Council of Trades Unions, was placed before the Associated Society on Saturday last; but Mr. Bromley insisted upon absolute departure from the decision of the National Railway Board, and precipitated the strike on Sunday night.

We believe these to be all the essential facts of the case. It will be seen that the strike is being pursued because 2400 men may be asked to submit to an average reduction of 7s. 5d. per week, and because less than 50 may have to face a reduction of three times that amount. Did these reductions represent a serious hardship or injustice, we cannot believe that the National Wages Board, which certainly showed no particular sympathy with the railway companies, would have consented to them, nor that the N.U.R., which has many members subject to them and to like reductions, would have agreed to them. The high rate was established when the cost of living was much greater than at present, and the new rates now in force certainly leave the men far better off than in pre-war days. It is needless to say that of all men connected with railway working there are none with whom we are in greater sympathy than the locomotive drivers and firemen; we like, without seeking for justification, to repeat their own claim that they are the *élite* of railway workers, and we admit that they

bear a burden of responsibility which is greater than that of any others, even of the signalmen. If any men have a right to high wages they have, and if the high rates for which they ask could be paid without injury to others, we should be the first to rejoice. But having said that much, we must point out to them that Mr. Bromley's idea of spoliation of the railway companies does not make for the country's good; that trade, which directly affects them, is groaning under high rates; that other men have accepted similar reductions; and, finally, that to repudiate the findings of the National Wages Board would render the work of that body on all future occasions nugatory. If they have, as we are convinced most of them have, a sincere desire for industrial peace, they will see, on reflection, that the only way to secure it is to accept, even when unpalatable, the findings of those bodies which have been established for the consideration of matters in dispute and for their settlement without struggles which damage the country, and frequently leave the men little, if any, better off than before.

Methods of Manufacture.

MANY points of difficulty arise when specifications, and particularly standard specifications for engineering materials, are to be drawn up. Among them is one which crops up perennially in connection with many varied materials—it relates to the question whether the specification shall confine itself to stating the properties required in the finished material, or shall go further and deal with the method of manufacture. As a rule, in all such matters, the intelligent and far-seeing manufacturer is ready to meet the wishes of the user, while the user, if he is wise, will consult the convenience and the experience of the manufacturer. It is, of course, obvious that the user must pay for that which the specification demands, and if the demands are unduly stringent the price will be correspondingly high. There are, furthermore, cases in which the enforcement of an ill-advised specification not only hampers industrial progress but subjects the manufacturer to an intolerable amount of interference on the part of an inspector possessed of more zeal than discretion. These are extreme cases, but even apart from them serious differences of opinion may still exist.

The whole question turns upon what is, in fact, a matter of fundamental principle. On the one hand it is often contended that so long as a material of a given type conforms satisfactorily to the mechanical tests imposed by the specification, there is no need to look further; the material, it is held, is proved by the tests, to be capable of rendering the desired service and, therefore, how it is made, of what raw materials, and what—within wide limits—it may contain is no concern of the purchaser. The correctness of this view is entirely dependent upon the primary proposition that the tests imposed are really adequate to prove the serviceability of the material for the purpose intended. Despite a great deal of correlative research some uncertainty on this point remains, but in any case, only a small proportion of any delivery is actually subjected to tests, so that the entire question of reliability in regard to uniformity of quality must, of necessity, remain to a considerable extent a matter of confidence in the manufacturer and in his methods of manufacture. Furthermore, reliance is nearly always placed on tests of a simple standardised type; it can scarcely be claimed, however, that such tests truly represent the service which the material is called upon to render. Tests for tensile strength and ductility furnish information of the highest value as to the general quality of the material, but it is only by inference based on long experience, that their indications can be trusted as a guide to service behaviour. The real point which must be borne in mind is that this inference, and the experience upon which it is based, must take account both of the composition of the material, and not less of the methods by which it has been produced. Put into explicit terms, it comes to this: Here is a material of certain composition, produced in a certain way, which is found to pass certain standard tests. We know from experience that material of this kind, made in this way and giving these tests, is satisfactory for our purpose and we are safe in accepting it. It may be, and indeed often is, the case that a newer or different method of manufacture produces material of equal or even superior quality and reliability, but its suitability for a specified purpose requires to be thoroughly established in each particular case. As a well known example, we may quote the case of basic and acid steel. The gradual admission of basic steel for purposes formerly reserved for acid steel is a result of the gradual winning of the engineer's confidence by the newer material. It would not have been reasonable at a time when the reliability of basic steel was still a matter of considerable doubt for manufacturers to suggest that it was no concern of the engineer by which process his material had been made. Until engineers were satisfied by prolonged experience that basic steel could be trusted they were right in insisting in their specifications that it should not be supplied. Numerous cases of a similar kind, although usually of less widespread importance, crop up from time to time, and in such cases, although rigid adherence to an established process which is known to be reliable, may cause temporary hardship to a newer process, and may even prove an obstacle to its development, yet that course seems to be quite necessary for safety. New processes are sometimes advocated, and are adopted by some manufacturers before adequate knowledge of their characteristics has been collected, with the result that in the long run they prove to be very far from satisfactory. Hence a certain degree of caution in such matters is incumbent upon the engineer.

While thus justifying the inclusion of specification clauses which relate to materials and methods of manufacture to be employed, we are far from wishing to urge undue conservatism in regard to new processes or to new views in regard to such matters as chemical composition. Metallurgy is constantly moving forward, and the engineer should be ever ready to avail himself of better and cheaper materials as soon as the elementary dictates or safety are satisfied. If a new process is as efficient but cheaper than an old, it cannot fail to make headway and to achieve recognition in specifications. Two things, however, are necessary. The first is that the new process shall be most thoroughly investigated under carefully controlled conditions, and by subjecting its product to tests of a very different order from those which can be imposed for routine purposes in any specification. When such tests have been successfully passed the new product may well claim to be taken into use, at least in a tentative manner. Even then, however, we would still insist upon our second point—that it should sail under its own colours and not under those of an older process. The "way out" in such a case is the establishment of a second or alternative specification for the material made by the new process, thus throwing the onus of choice on the purchaser, who can order to either specification. And the new process is not in any sense handicapped thereby; if it is really as good as or better than the old and is at the same time cheaper, before long the engineer will be ready to avail himself of it to a steadily increasing extent. The purchaser, however, is definitely entitled to know what he is buying, and that knowledge, in many cases, must be based on information as to the raw materials used and the manufacturing process employed.

Literature.

The Internal Combustion Engine. By H. R. RICARDO. Vol. I., Slow-speed Engines; Vol. II., High-speed Engines. Each 30s. net. Blackie and Son, Limited, 50, Old Bailey, London.

MR. RICARDO'S contribution to the development of the internal combustion engine has been, particularly during the last few years, by no means a small one, and his two-volume book, which was completed in the summer of last year, is of interest, therefore, as being the work of one who is a specialist in the subject upon which he writes.

As the title implies, the first volume deals exclusively with engines of the slow-speed type. In his preface the author says that the material for the book was prepared before the war, but that the general notes about, and descriptions of, engines which are no longer built hold good to-day, because the slow-speed engine, unlike the high-speed type, has undergone little change. While this statement may be more or less true of some types of gas and oil engines, we think that the pre-war outlook imposes very severe limitations on the chapters dealing with such engine types as the cold-starting high-pressure engine and the Diesel engine, both in their land and marine applications, in which far-reaching advances have been made. Even with this handicap, which, no doubt, the author will seek to remove in an early revised edition, the first volume is one which contains much valuable material for the designer and the student.

In the early chapters a clear account is given of first working principles, and the various cycles of operation are described and their efficiencies deduced. Thereafter follows a consideration of the thermal efficiency of a prime mover, and the sources of loss of efficiency. The gas engine, and the four-stroke and two-stroke Diesel engine, are then analysed, and the questions of the mechanical efficiency and its determination are discussed. Closely connected with the question of mechanical efficiency is the subject of piston friction, volumetric efficiency, and the effect of the compression ratio, and to these special chapters are devoted.

In the sections devoted to details of design and mechanical construction, an interesting chapter is that dealing with pipework and the gas velocities, pulsations and inertia forces, which are met with in the exhaust and inlet pipes of multi-cylinder engines. This is an important subject which has not been, perhaps, sufficiently discussed in earlier books. We may quote the author's view that the matter is so important that it is no exaggeration to say that in the design of an engine, the pipework should first be arranged, and the rest of the engine put in where there is room for it. Balancing and synchronous vibration are reviewed at length, and most of the well-known types of engines are dealt with, the results being neatly summarised in a table.

The main part of the book is taken up with descriptions of two-cycle gas engines of both the large and small types. In the former we note with interest an account of the Fullagar gas engine, although no reference is made to its later development as an oil engine. The large gas engine is described very fully, and most of the important types are illustrated. Representative types of medium-powered gas and oil engines are also given, and the volume closes with a section on Diesel engines. This, as we have previously said, is limited, and no account is given of the later Sulzer, Werkspoor or Harland and Wolff types, the Beardmore-Tosi, the Camallaird-Fullagar, or the Scott-Still marine engines.

In the second volume Mr. Ricardo is dealing with a subject peculiarly his own, namely, the high-speed engine, and we have no hesitation in saying that he gives in this book, not only a fascinating account of the extraordinary development of the high-speed internal combustion engine which took place during the war, but spares no pains to analyse to the full the scientific basis upon which internal combustion engine design rests. The first two chapters deal mainly with the question of volatile liquid fuels, and the tables of physical and chemical characteristics which are given are the most complete we have yet seen. Considerable emphasis is laid upon the tendency of fuels to detonate, and the causes of detonation, and what means may be taken to counteract them are discussed. A valuable section of the early chapters is that in which the author gives a summary of the research on volatile liquid fuels instituted by the Asiatic Petroleum Company. In the third and fourth chapters an account is given of the distribution of heat in a four-cycle high-speed engine, and interesting conclusions are drawn from the analysis, while the influence of the form of combustion chamber is shown by means of a series of illustrations of standard types of engine.

The chapter on lubrication and bearing wear is outstanding in interest on account of the conclusions the author draws. In order to reduce wear on a shaft it is desirable, he says, for the difference in hardness between the shaft and the bearing metal to be as large as possible. Thus, when a steel shaft is running on a white metal bearing, a soft white metal enables any particles of grit to become quickly embedded out of harm's way, and the hard surface of the steel shaft more easily resists the cutting action of any particles which may not be so completely embedded. According to the author, all the evidence would seem to point to the fallacy of the once popular idea that a hard white metal should be used. Indeed, on the contrary, it should he maintains be as soft as is consistent with the necessary resistance to the crushing stresses imposed by the loading of the bearing.

Some useful information is contained in the same chapter on the loading of bearings and the grade of lubricating oil most suited to different kinds of duties. After a brief section on carburation and ignition, the problems of the mechanical design of high-speed engines are individually discussed by the author under such headings as auxiliary drives, lubricating details, valves and valve gear, and piston design. All these chapters are well illustrated with drawings and curves. A further section of this volume deals with engines for road vehicles, and several specific examples are given, which include the 14 horse-power Vauxhall engine, the Burt sleeve-valve engine, and the 3-litre high-output racing engine, also designed by Vauxhall Motors, Limited. In this chapter very complete performance curves are given, and an example of port circulation for an engine of the sleeve-valve type is worked out.

To many readers the last chapter and the one before it will prove of unusual interest, for the volume concludes with a very complete account of the aero engine, and of the high-speed heavy-duty engine as developed for use in the Tanks. In the section

devoted to aero engines, drawings and illustrations of almost every type of aircraft engine are given, and there is a useful section on supercharging. Although Dr. Rateau's name is not mentioned, his supercharging system is described, as is also the port system, first introduced by Sir Dugald Clerk, for large gas engines. The last chapter, devoted to engines for "Tanks," is supplemented by a complete specification of the 150 horse-power engine, and performance curves and efficiencies are also given.

A complete index to both volumes is included in Vol. II. Mr. Ricardo is to be congratulated on the excellent way in which he has set forth the evolution and development of the high-speed engine, and for placing on record the results of much careful research and experiment which cannot fail to stimulate further endeavour.

A Treatise on Electro-Metallurgy. By WALTER G. MCMILLAN. Revised by W. R. COOPER, M.A., B.Sc., A.I.C. Fourth Edition. Revised and Enlarged. 128 Illustrations. xv. pp. 449 pp. text. Price 21s. Published by Charles Griffin and Co., London.

THIS fourth and enlarged edition of the well-known treatise upon "Electro-Metallurgy," by Walter G. McMillan, the first edition of which was published in 1891, or over thirty years ago, has been revised and brought up to date by Mr. W. R. Cooper. As stated in the new preface, great advances have been made in electro-metallurgy since the last edition appeared in July, 1910 and the progress has been so great in one or two directions, that quite an extensive literature of these branches has been created. On this account, the description of electric welding, which was formerly included in this volume, has been omitted altogether; and merely a brief account of the electric furnace methods of iron and steel production is now given, since there are now several books published dealing entirely with this subject.

On the other hand, the electrolytic method of refining copper, the wet methods of extracting zinc from its ores, and the newer methods of electro-depositing cobalt, are dealt with at considerable length in this latest edition; and upon all branches of electro-plating and the electro-deposition of metals from aqueous solutions, McMillan's book will remain the standard work in this country. Chapters I. to XIV. are devoted to this branch of the subject; and in them the electro-deposition of copper, silver, gold, nickel, cobalt, iron and other metals are very fully described; while one chapter is devoted to the electro-deposition of brass and other alloys.

Chapters XVI., XVII., XVIII, and XIX. also deal with subsidiary branches of electro-plating, and may be considered as belonging to the first portion of the work. Chapter XV. is an "omnibus" chapter, extending to 74 pages—or to one-fifth of the whole book—and deals with the wet methods of extracting and refining metals by electricity. It would be preferable now, however, to deal with this branch of electro-metallurgy separately from the other and in a separate volume; for its literature is growing extensively; and Chapter XV. as it stands is hardly satisfactory. The use of electricity for iron and steel production, for example, is quite different, in principle, from the other applications dealt with in Chapter XV. It will be advisable in future editions, therefore, to drop this subject entirely, and to concentrate attention on the various processes of metal extraction and refining by the electrolysis of aqueous or fused solutions, devoting separate chapters to copper, zinc, lead, gold, silver and aluminium.

The book is well printed and illustrated, and is provided with a very good index and with a useful glossary. One mistake which might be corrected in future editions occurs on page 229, where the word "nickel" is used in line five, in place of "metal."

Recent Progress in Gears and Gear Cutting.

"RECENT Progress in Gear Cutting" was the title of a paper read before the North-Western Branch of the Institution of Mechanical Engineers on Thursday, 17th inst., at Manchester, by Mr. I. H. Wright, M.I. Mech. E. After briefly reviewing the trend of practice in this branch of mechanical engineering, the author said that the fuller realisation of the sufficiency of the involute curve and the undesirability of empirical modifications had emphasised the necessity of ignoring standard values, either of pressure angle or the working height of the teeth, both of which were now varied to meet the requirements of each pair of gears in such a way as to avoid the bad features of the older interchangeable systems, and to insure other desirable qualities which received little or no consideration in the older systems. The precision demanded in high-speed gears for large powers now presented a problem which gear-cutting machine builders were earnestly trying to meet, whilst engineers were also interesting themselves in the mounting and supporting of such gears to give the maximum of efficiency. In modern generating machines, the variations of pressure angle, pitch and working height were all produced by modifications of the blank diameter, and the depth to which the cutter is sunk into the blank; the known relation

$$\frac{\text{new pitch}}{\text{cutter pitch}} = \frac{\cos \text{ cutter pressure angle}}{\cos \text{ new pressure angle}}$$

governing the pitch and pressure angle, the working height, which gave the necessary depth to sink the cutter, being subject to a modification to restore the correct thicknesses of teeth on the pitch line or preferably at the root.

Mr. Wright said that in deciding the desirable pressure angle and tooth height for a given case, the main points for consideration were:—(*a*) Avoidance of involute interference; (*b*) provision of a sufficient duration of action; (*c*) avoidance of excessive sliding; and (*d*) equality of tooth strength in both gears. It was pointed out that (*a*) was the requirement which caused the departure from the old interchangeable systems, and was met when the outside circles of both gears intersected the generating tangent to both base circles at points within the points of tangency. Only with very small numbers of teeth and low ratios, say below 2 to 1, was that really the limit; for moderate numbers of teeth and higher ratios point (*c*) modified it. With small numbers of teeth and low ratios avoidance of involute interference usually demanded both an increase of pressure angle and an unsymmetrical disposition of the working height above and below the pitch line. With ratios over about 2 to 1 the pressure angle might be low, the tooth heights being modified to bring the active face of the smaller gear outside its base circle.

With the full involute action assured as under (*a*) the required duration of action was now less than formerly, a minimum of about 1.25 tooth in action being acceptable; that is to say, the intercept of the generator tangent between the two outside circles, divided by the base circle pitch—cutter $p^{\prime}$ cos β—should not be less than 1.25. This reduction in the required duration of action permitted a reduction in height of teeth and consequent gain in cantilever strength. (*c*) At the pitch line only did pure rolling occur. At other positions of the point of contact along the generator tangent, rolling was accompanied by sliding, until at the point of tangency with the base circle sliding only occurred. Action near the base circle was, therefore, undesirable, as heavy wear was localised there. The lubrication conditions were also poor, as compared with those positions at which some rolling was occurring, since the rolling appeared to help lubrication. Further, the radius of curvature of the teeth surface near the base circle was very small, and its load-carrying capacity consequently low. These adverse conditions were somewhat reduced by the fact that when action was occurring at such a point there was another pair of teeth in contact.

The teeth of pinions in the established interchangeable system were, the author said, notoriously weaker than those of big gears, largely on account of interference, but also because they were necessarily made of equal thickness on the pitch line, and, in consequence, varied in thickness at the root, which was the place where tooth strength must be estimated.

In making the changes required by consideration (*c*) it was found that point (*d*) was largely met, but if tooth strength in a given case was the more important quality, sliding and rolling might be sacrificed and the thickness of the teeth at the root made the chief factor.

The shifting of the cutter from its standard setting thus comprised two elements:—First, an outward shift, such that the cutter would produce tooth thicknesses at the pitch line whose sum equalled the pitch, or less any desired backlash, and for equal pitch line thicknesses this shift must be $\frac{N}{n}$ times as much for the gear as for the pinion. Secondly, having decided the sum of these shifts for the two gears it might be divided between them in such a way as to equalise the root thicknesses and meet the requirements under the heading (*c*).

The author pointed out that all these shifts were outward and reduced the working height of the teeth somewhat. In fact, the range of variation which could conveniently be produced with one cutter was limited by the effect of this reduction of height on duration of action, and as the thickness correcting shift was a function of the co-tangent, the pressure angle of low-pressure angle cutters would be seen to have a rather small range, while cutters with larger pressure angles with wider range were to be preferred even if, as was the case, gears of low-pressure angle could not be produced with them.

The principal features of many of the best-known gear-cutting, generating and grinding machines were described by the author, including the Muir, Fellows, Sunderland, the Robey Smith and the Maag and Gear Grinding Company's machines. Referring to the last named machine, the author said that the grinding was performed by a wheel turned to the space contour, the turning being effected by diamonds controlled by a pantagraph mechanism from a much enlarged template made by careful laying out. It thus ground a complete space at each pass, and had a stroke greater than the face width of the gear. The pantagraph mechanism was carefully set in relation to the wheel axis, and the grinding wheel advanced as it became worn until finally it completed a full rotation of the wheel being ground with a very light grinding cut.

The paper was illustrated by lantern slides and produced an interesting discussion.

Obituary.

JOHN WALTER BROOKE.

WE much regret to have to record the death of Mr. John Walter Brooke, chairman of J. W. Brooke and Co., Limited, of Lowestoft, which took place on Saturday morning last, the 19th inst.

Mr. Brooke, who was in his seventy-fifth year, was born at Redbrooke, near Barnsley, and was educated at Charterhouse, thereafter being apprenticed at a foundry and engineering works in London, and eventually going to America for three years for further engineering experience. He founded the firm which bears his name in 1874.

Mr. Brooke was a man of indomitable energy, and, in addition to his other activities, took the greatest interest in the public life of the borough of Lowestoft, of which he was Mayor for three years—1914, 1915 and 1916. At the time of his death he was an alderman of the borough; he was also a magistrate of both the borough and county of Suffolk, and took a very deep interest in this work. He served on many committees, was a member of the Charity Board, and during the war was the backbone of the local community in their anxious times of bombardments and air raids. He took a very prominent part in the formation of the V.T.C., was chairman of the Tribunal, and after the war was awarded the O.B.E. He was one of the very early members of the Royal Automobile Club, and one of the founding members of the British Motor Boat Club. He was also a Member of the Institution of Mechanical Engineers. He is succeeded in the position of chairman of the company by Mr. Mawdsley Brooke, who has been managing director of the business for several years.

SIXTY YEARS AGO.

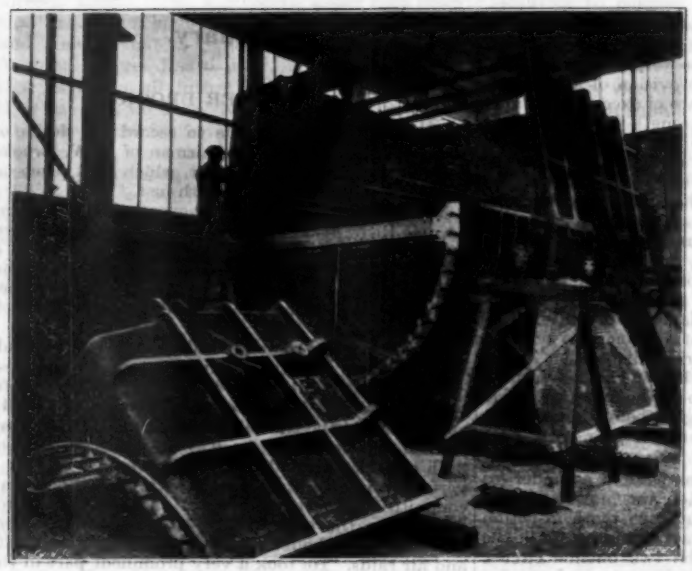
IN our issue of January 22nd, 1864, a prominent place was accorded to the first part of Mr. Perry F. Nursey's paper entitled "On Fuel," which was read before the Society of Engineers on January 18th, 1864. The author stated that the object he had in view was to adduce facts, opinions and evidence which might awaken research and promote discussion, with a view to ultimate practical improvement. A complete survey of the physical properties and economic values of coals raised in various parts of Britain was given, and the work of Sir H. De la Beche and Dr. Lyon Playfair on the comparative values of different coals for steam raising in the Navy was cited. These two gentlemen, it appears, had, under Admiralty instructions, undertaken an experimental investigation of this subject. The use of coke for locomotive firing was discussed and interesting particulars were given concerning the different designs of coke ovens then in use, notably Church's and Cox's types. It was pointed out that considerable waste took place in the non-recovery of by-products, and the heat lost in quenching the glowing coke. Steaming was also referred to as a means of increasing the amount of gas produced. An interesting part of the paper was that which dealt with the use of compressed peat for river boats and locomotives, and in it we find an account of a locomotive trial carried out under the superintendence of Mr. Yorston, Mr. Stephenson and Mr. Domville, on the Belfast and Northern Counties Railway. A trip was made from Carrick Junction to Ballymena, a distance of about 27 miles, and during the whole journey there was, it was stated, an excess of steam. The smoke-box, when examined, was perfectly free from cinders or dust, which was taken as a proof that the fuel had withstood the blast very well. The recorded opinion of the experimenters was that the condensed peat was in every way adapted as a fuel for locomotive purposes. With a train of 70 tons, including the locomotive, tender and seven carriages, a total run of 74 miles was made in 3 hours 9 minutes, 21.47 lb. of peat fuel being used per mile. The paper concludes with an account of the advances then made in the manufacture of patented fuels.

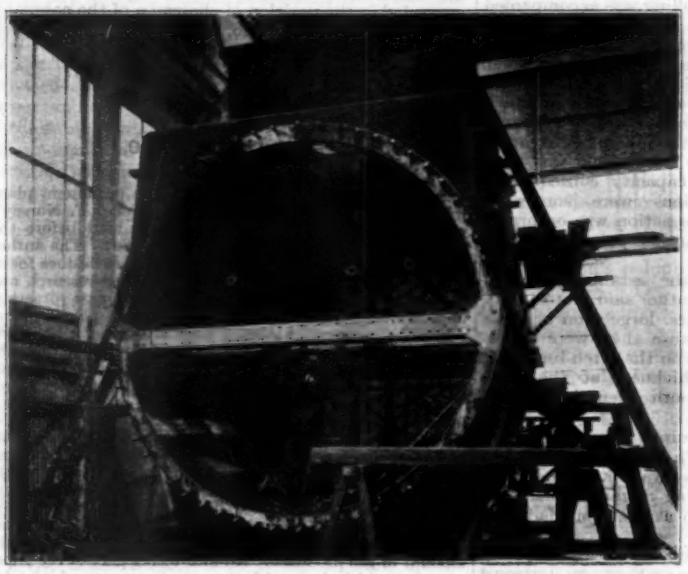
Turning to naval construction, we find an account of the machinery for the iron frigate Achilles, which was then fitting out at Chatham, over 1000 mechanics being employed on her. The engines were designed to develop 1250 horse-power, and were constructed by Messrs. Penn and Sons. Some particulars of the machinery weights may be given. The cylinders were among the largest then constructed for naval ships, and each weighed between 29 and 30 tons. Two condensers weighed each over 23 tons, and there were ten boilers of nearly 22 tons each. The heavy machinery parts were shipped on board without accident by means of the floating masting sheers, which were towed down to Gillingham for that purpose. A less worthy vessel we described was her Majesty's paddle yacht Alberta. She was designed to ply between the mainland and Osborne, but was apparently anything but a good sea boat, for our account concludes with the following words:—"The Alberta, in fact, is nothing more than a thing without form, driven through the water by tremendous engine power, but not worthy of the position of a yacht for her Majesty's private service, and a perfect disgrace to her designers."

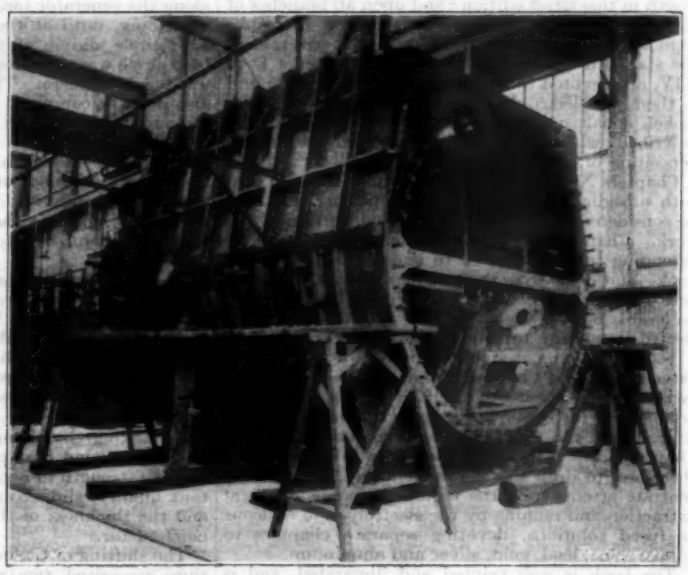
A VERY LARGE SURFACE CONDENSER

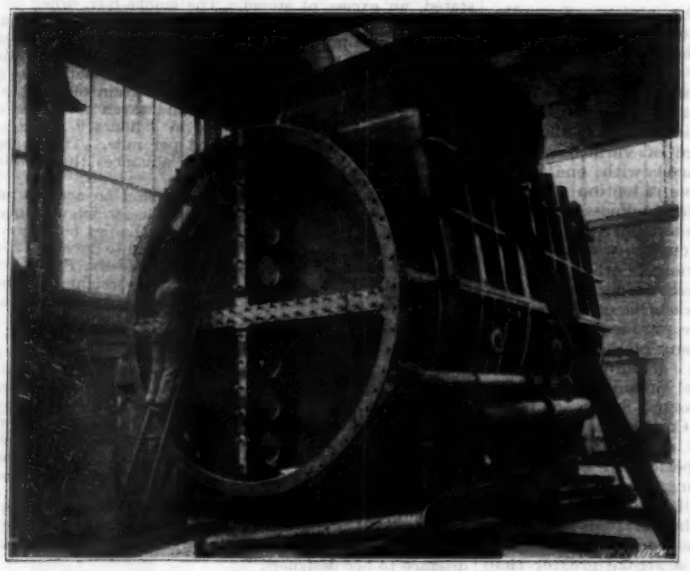
W. H. ALLEN, SONS AND CO., LIMITED, BEDFORD, ENGINEERS

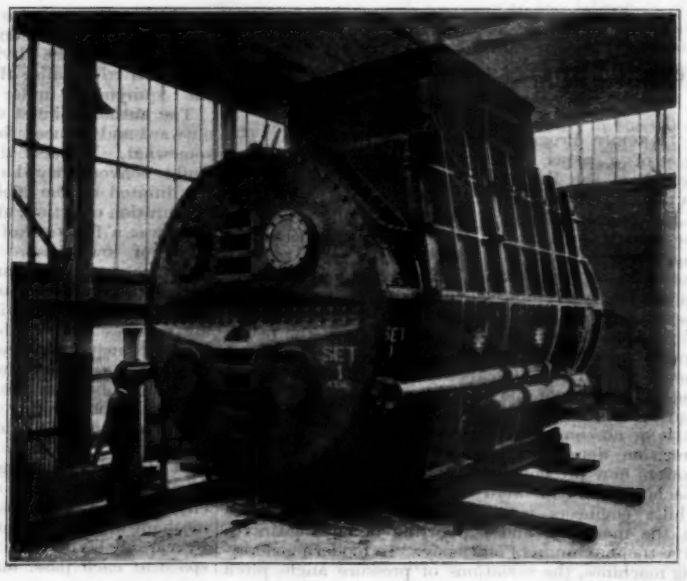
(*For description see opposite page*)











A Very Large Condenser.

ONE of the largest surface condensers ever constructed in this country, which has just been shipped abroad by W. H. Allen, Sons and Co., Limited, of Bedford, is illustrated by the engravings on page 100.

This condenser, which is one of two which are to be used in connection with two 30,000-kilowatt turbo-generator units being installed in a large hydraulic power station, is noteworthy not only on account of its exceptional size, but also as it had to be so built that it could be easily transported. As a consequence of the latter requirement, the shell, which is of cast iron, has been made in twelve separate sections. It will readily be appreciated that the machining of these pieces of shell required a high degree of skill, as they must come together, in two different directions, with air-tight joints and also conform exactly with the designed dimensions.

Each of these condensers, which are of the Contraflo type, is 19ft. 5in. long between the tube plates and has an internal diameter of 13ft. The cooling surface amounts to as much as 35,000 square feet. The outside dimensions of the complete condenser are 27ft. 1in. long by 13ft. 10in. wide by 15ft. 1in. high.

In view of these unusually large scantlings, it was naturally necessary to provide, in the design, adequate stiffening to withstand the external atmospheric pressure when the condenser was at work, and an elaborate system of strengthening ribs and cross stays was arranged for, as can be seen from the engravings.

The tube plates, of rolled brass, had to be made in two sections each, as single plates of sufficient size could not be obtained and the joint between the halves is made on the horizontal diameter. Behind this joint—that is to say, in the steam space—there is a stiff cast iron girder, which not only helps to keep the joint tight, but also resists the external pressure. This girder is shown plainly in two of our engravings. Further support for the tube plates is provided by a vertical girder in the water box, while the diaphragm used to separate the two parts of the water box, for double flow, also helps to stiffen the structure.

The covers for the water boxes, it will be noticed, are also divided on the horizontal diameter, and are symmetrical, so that all the four pieces, for the two ends, could be cast from one pattern.

There are 6886 tubes to provide the necessary cooling surface, and as the length between the tube plates is unusually long the tubes have been made 1in. in diameter and are supported by a plate half-way along their length. The tubes are secured in the tube plates by the usual type of screwed ferrules and linen tape packings.

The internal diameter of the main body of the condenser is larger than is necessary for the tube plates, and this construction, combined with a large exhaust hood, allows a slow steam speed to be maintained at the entry to the tubes, a point generally considered to be of primary importance in designing an efficient surface condenser. This characteristic is well illustrated in the view which shows the tube plate in position during the erection of the condenser in the shops, and also shows the wider pitching of the tubes over the top of the tube plate and the arrangement of steam guide plates adopted.

This design of tube plate is on the Contraflo principle and provides compartments of triangular section, which gradually concentrate the air and vapour towards the devapourising chambers, from which the air is withdrawn by two sets of kinetic rotary air pumps.

For supporting the condenser body six spring feet are provided, a seventh being fitted under the inlet water box to take the weight of the water box and circulating water connections.

The condensers were completely erected in the makers' works with the exception of the tubing, and, after marking, to facilitate re-assembly on site, were dismantled and packed for shipment.

Two circulating pumps, each of a capacity of 19,350 gallons per minute and driven by alternating current motors of 180 rated brake horse-power, are provided for each condenser. With a view to economy at light loads on the main turbine, the plant has been so designed that only one circulating pump need be in use until the load is well over half the normal full load. For controlling the circulating water 34in. sluice valves are fitted, each valve being operated by a direct-current electric motor to ensure ease of manipulation.

Two complete sets of air pumps are installed, each being of the kinetic rotary type, the air being withdrawn from the condenser by a steam ejector of the single jet type. The steam and entrained air and vapour are discharged into a small surface heater in which the steam is condensed, and all the heat of the steam is absorbed by the feed water. A vacuum is maintained in the steam space of the heater by means of a water-operated ejector which withdraws the air and vapour and discharges into a small kinetic tank. A separate pump, driven by its own motor, is installed to provide pressure water for each of the water ejectors.

For withdrawing the water of condensation from the condensers duplicate extraction pumps are fitted. They are of the "head" and "pressure," or two-stage, type, in which the head on the suction side of the pump is very small. These pumps are also driven by separate motors, and the whole plant has been so designed that, if any single unit should fail, the main turbine can still run at a load closely approximating to full rated capacity.

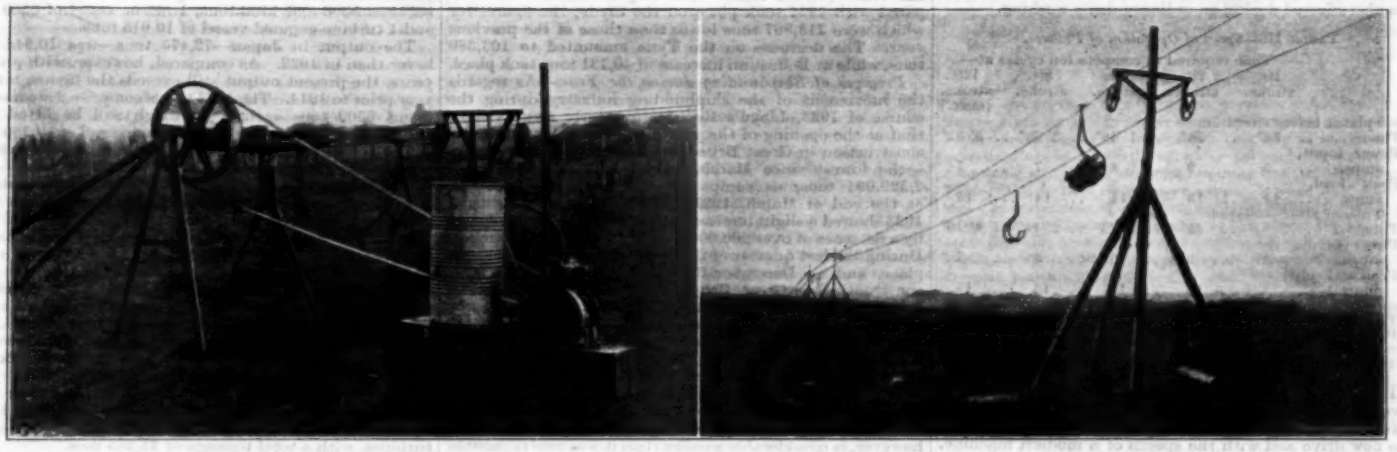
A Light Aerial Rope Conveyor.

AERIAL ropeways are, of course, a well-established means of transport, and are used for a variety of services all over the world, but generally speaking they are of a rather elaborate character and intended for fairly heavy work. At the other end of the scale there is, however, a light ropeway recently brought out by Artex, Limited, of Cippenham Works, Slough, illustrated by the two engravings above.

The mechanism really needs very little description, as it follows orthodox designs in general principles, and the construction is fairly obvious in the engravings. It will be noticed that all the parts are very simple in form, and are bolted together, so that they may be easily taken apart for transport. The driving terminal is mounted on two A frames, which are tied together by a bar running through the centre of the driving shaft, and a simple bevel reduction gear is used to transmit the power. Any convenient source of power, such as the little petrol engine shown, can be used to operate the ropeway, while if the loads are delivered on a down gradient, the engine may have to be replaced by a brake.

The intermediate supports for the wire rope are carried on posts spaced from 50 to 60 yards apart, and can be arranged as regards height to allow for inequalities in the ground level or for crossing rivers and roads. The wire is not spliced, but is joined by a patented coupling, which can, we are told, be fastened in one minute. The form of the hangers for carrying the loads naturally depends on the class of materials being handled.

These light ropeways should be very useful for services where the individual loads are not very heavy, and specially where it is necessary to move the plant from time to time, while they have the great advantage over light railways that they do not obstruct agricultural operations or traffic on the ground below, and can easily be erected across swampy country.



DRIVING TERMINAL OF LIGHT ROPEWAY ARRANGEMENT OF INTERMEDIATE SUPPORTS

Tests of a Reversing Drive for Planing Machines.

WE have on more than one occasion referred to the reversing gear for driving planing machines manufactured by Newton Brothers, Limited, of Derby, and in our issue of July 20th, 1921, described it in some detail. On that occasion we explained that although the gear is generally associated with an electric motor, as prime mover, it is essentially a mechanical device employing epicyclic gears and brakes for the reversal of motion, while we pointed out the excellent features of the apparatus in the way of speeding up production and economy of power.

Various tests, made since then, have confirmed our opinion of the gear, but some of the most conclusive results have just been sent to us by Messrs. Newton, and in view of the fact that they were made on a planing machine almost twenty years old, recently converted to the new drive, we give some particulars of the trials below.

The machine in question is one of several in the machine shop of Messrs. Wadkin and Co., the wood-working machinery makers of Leicester, and is shown in the foreground of our engraving. This machine was originally driven through a magnetic clutch of Austrian make, but in comparison with its more modern neighbours, several of which, it will be noticed, are driven by individual electric motors, its output was so low that the owners decided to alter the system of driving. It was consequently equipped with a Newton reversing drive, and the results of the tests referred to above show that it is now actually faster than the more modern machines alongside. It is fortunate in this connection that the other machines have individual motors and control panels, as the arrangement has enabled a very direct comparison of performance to be made. The figures given in the tables below were, by the way, supplied to the makers of the gear by Messrs. Wadkin.

The old, converted, planing machine is capable of deal-

OLD PLANING MACHINE WITH NEW REVERSING GEAR

ing with work, 3ft. 6in. by 3ft. 6in. by 12ft., while the other machines are of closely comparable dimensions, although none of them is precisely the same.

Two kinds of tests were made. One was to determine the amount of power consumed by the machines when running light and during an ordinary day's work, while the other was to find out how quickly the table would travel through a double stroke—cut and return—without actually planing, for various lengths of stroke.

TABLE I.—*Power Consumption Test of Planers.*

Description of machine.	Units consumed in 1 hour at 4ft. stroke running light.	Units consumed in 1 day's run at work.
3ft. 6in. by 3ft. 6in. by 10ft. planer, installed 1923, direct motor drive, motor mounted on X rail	5½	32
3ft. by 3ft. by 10ft. planer, installed 1920, with belt drive from independent motor mounted on gantry	4½	31
3ft. by 3ft. by 10ft. ditto	5	40
3ft. 6in. by 3ft. 6in. by 12ft. old planer, maker unknown, fitted with new "Newton drive"	3	20

Table I. gives the results of the power consumption tests, and in connection with it the makers point out that although the table of the converted machine is 20 per cent. larger as regards length, a saving of 42 per cent. in power consumption was registered when running light on a 4ft. stroke. A very considerable saving, it will be observed, was also effected during an ordinary day's working.

TABLE II.—*Speed of Operation of Planers.*

	Time required to compete ten cycles at— 1ft. stroke.	2ft. stroke.	4ft. stroke.	8ft. stroke.	12ft. stroke. (max.)
No. 6 planer before alteration—					
Time	34″	58″	1′ 48″	3′ 32″	5′ 32″
Power input, amps.	9	9	8	7	7
Peak load, amps.	17	15	14	14	13
No. 6 planer after alteration—					
Time	*	45″	1′ 25″	2′ 44″	4′ 16″
Power input, amps.	*	3	3	3	3
Peak load, amps.	*	15	15	15	15
Motor-driven planer, No. 7—					
Time	—	50″	1′ 28″	2′ 46″	4′ 14″
Power input, amps.	—	9	9	9	9

* Stops do not permit of 1ft. stroke.

In Table II. a comparison is made between the speed of reversal and travel of the table of the old, No. 6, machine before it was altered, with the speeds after it was fitted with the new drive and with the speeds of a modern machine, —No. 7,—just installed. It will be noticed that the alterations not only resulted in a very considerable acceleration, but also effected an economy in power.

The maximum cutting speed of the old planer before it was altered was 34ft. per minute, while the return stroke was effected at 70ft. per minute. After the new gear had been fitted, these speeds were increased to 36ft. per minute and 144ft. per minute respectively. The peak load readings for the new planer are not given, as the ammeter was only graduated up to 25 ampères and the pointer went up to the stop with a bump. It was estimated that the current might be anything between 35 and 40 ampères.

Lloyd's Register: Annual Summary.

LLOYD'S annual summary of the mercantile shipbuilding of the world for the year 1923 has just been published, and in accordance with our usual custom we give a *précis* of its contents in what follows. It will be remembered that this summary does not include warships, and that it takes into account only merchant vessels of 100 tons gross and upwards that were launched in 1923, whether they were completed during the year or are still under construction. Sailing vessels fitted with auxiliary power are included with steamers or motor vessels, according to type of engine. Returns are not available as regards Germany and Austria-Hungary for the war period (1914–18), nor as regards Germany for 1919 and 1920.

GREAT BRITAIN AND IRELAND.

Particulars of Total Output.—During the year 1923 there were launched in Great Britain and Ireland 222 merchant vessels of 645,651 tons (viz., 179 steamers of 553,223 tons, 21 motor vessels of 87,244 tons, and 22 barges of 5184 tons). All these vessels were built of steel and not a single sailing vessel was launched during the year. The output for 1923 is 385,430 tons lower than the figures for 1922, and represents 39.2 per cent. of the world's output for 1923, as compared with 41.8 per cent. in 1922 and 58 per cent. in 1913. Apart from the war years 1915 and 1916, the lowest output of any year, during the thirty-one years 1892–1922, was in 1893, when 836,383 tons were launched —nearly 30 per cent. more than the total for 1923.

Nationality of Vessels Launched.—Of the tonnage launched during the year, 626,805 tons are for registration in Great Britain and Ireland, and 18,846 tons (under 3 per cent. of the total tonnage) are for owners residing abroad. This percentage, compared with 26 per cent. for the previous year, and an average of over 22 per cent. for the five pre-war years, 1909–1913, very clearly indicates the great difficulties British yards have had to contend with during the year under review.

Size and Type of Vessels.—The returns for 1923 show that 38 vessels of between 5000 and 10,000 tons each, and 10 vessels of 10,000 tons and upwards were launched. The following are the largest :—

	Tons.
Minnewaska	21,716
Mooltan	20,847
Maloja	20,837
California	16,792
Ascania	13,911
Voltaire	13,248

Excluding vessels of less than 1000 tons, 9 vessels of about 58,200 tons for the carriage of oil in bulk were launched during 1923. Of them, 5 vessels of about 30,500 tons were built on the Isherwood system of longitudinal framing. The returns also include a number of vessels designed for Channel, coasting, fishing, harbour service and other special purposes. The average tonnage of steamers and motor vessels launched during the year was much lower than usual, viz.:—3202 tons; if the vessels of less than 500 tons were excluded, however, the average would be increased to 3805 tons, as compared with 5186 in 1922, 4602 in 1921, 4387 in 1920, 4006 in 1919, and 4593 in 1918.

Vessels Fitted with Turbines.—Further progress was recorded in the use of steam turbines during 1923, when 11 vessels with a total tonnage of 121,075 tons were launched, which will be fitted with that method of propulsion, and all of them will have geared turbines. It may be stated that of the vessels of 10,000 tons and upwards launched during the year, 6 are to be fitted with turbines.

Vessels Fitted with Internal Combustion Engines.—During the year 21 motor vessels of 87,244 tons were launched, and 8 of them are of 5000 tons and upwards, the largest being of about 9500 tons. These figures include 2 vessels, of 3682 tons each, with electric motive power; oil engines being employed to drive the generators which supply the power to the propelling motors.

Output of Leading Ports.—The Clyde district occupies first place amongst the shipbuilding centres, showing an output of 173,201 tons. Then follow the Tyne (137,408 tons), Belfast (127,426 tons), the Tees (66,573 tons), and the Wear (51,561 tons). The largest decrease as compared with 1922 took place on the Clyde, the figures for which were 218,867 tons lower than those of the previous year. The decrease on the Tyne amounted to 103,380 tons, while at Belfast an increase of 40,131 tons took place.

Progress of Shipbuilding during the Year.—As regards the movement of the shipbuilding industry during the course of 1923, Lloyd's Register quarterly returns show that at the opening of the year 1,468,599 tons were under construction in Great Britain and Ireland. These figures —the lowest since March, 1916—show a reduction of 2,329,994 tons, as compared with the record reached at the end of March, 1921. The returns issued during 1923 showed a slight increase at the end of March, followed by a decrease of over 200,000 tons by the end of September. During the last quarter of the year a decided increase took place, and on December 31st, 1923, the tonnage under construction in Great Britain and Ireland amounted to 1,395,181 tons, only 73,418 tons less than twelve months ago.

These figures do not sufficiently indicate the actual position of the shipbuilding industry in Great Britain and Ireland in comparison with normal years, as account should be taken of the fact that the total returned as under construction at the opening of 1924 includes about 164,000 tons on which all work is suspended. This total, however, is considerably smaller than it was twelve months ago, and taken in conjunction with the fact that orders for new ships have recently increased, as shown in Lloyd's Register returns for the fourth quarter of 1923, where it is stated that the vessels commenced during that quarter amounted to about 245,000 tons, it may reasonably be hoped that, in the absence of unforeseen adverse circumstances, an improvement may shortly become apparent in the conditions of the shipbuilding industry.

OTHER COUNTRIES.

Particulars of Total Output.—There were launched abroad during the year 479 merchant vessels of 997,530 tons (339 steamers of 835,527 tons, 81 motor vessels of 138,796 tons, and 59 sailing vessels and barges of 23,207 tons). The figures show a decrease of 438,473 tons, as compared with those for 1922, and of 4,526,577 tons as compared with 1919—the record year—and they are 403,199 tons lower than those for 1913, during which year the highest pre-war total was reached.

Size and Type of Vessels.—The returns for the year include 37 vessels of between 4000 and 6000 tons each; 27 of between 6000 and 8000 tons; 15 of between 8000 and 10,000 tons; and 8 of over 10,000 tons each, the largest being the turbine-engined Deutschland of 20,602 tons, launched at Hamburg. There were launched during the year 25 vessels of a total tonnage of 182,529 tons to be fitted with turbines, the great majority of which are geared turbines. Of these vessels, 21 are of over 5000 tons each, including 4 of between 10,000 and 11,350 tons and 1 of 20,602 tons. Excluding vessels of less than 1000 tons, the output abroad for the year also comprised 15 steamers of about 71,600 tons built on the Isherwood system of longitudinal framing. Including 7 of these vessels of about 43,600 tons, there were launched during the year 14 vessels of a combined total of about 68,000 tons for the carriage of oil in bulk. During 1923 there were launched 81 vessels of 138,796 tons to be fitted with internal combustion engines; 15 of these vessels are of over 4000 tons each, 7 in Germany, 3 in Denmark, 2 in Sweden and 1 each in France, Holland and Italy, the two largest being 2 of about 8950 tons each, built in Germany. The total figures include a number of sailing vessels fitted with auxiliary power. Although no large motor vessels were launched in the United States during 1923, it may be of interest to note that the totals for that country include 8 vessels, with a total tonnage of 11,545 tons, which will have electric drive, oil engines being used in conjunction with electric motors. The tonnage of wood vessels included in this year's total is 13,974 tons, as compared with 34,454 tons in 1922, and 1,145,582 tons in the war year 1918, when the tonnage of wood vessels launched amounted to 28 per cent. of the total output. The total figures include a very large proportion of barges and other craft which cannot be described as real sailing vessels, these latter amounting to less than 10 per cent. of the total tonnage shown under the heading of "Sailing Vessels and Barges." The countries in which the largest output took place during the year under review were Germany, United States, France, Japan, Italy and Holland. The totals for these countries amount to 836,364 tons, and account for 83½ per cent. of the total output abroad.

During the year under review, 117 vessels of 358,273 tons were launched in German yards. For the purpose of convenience of comparison with the output of previous years these figures comprise the 8 vessels of 13,211 tons launched at Danzig. As compared with the output for 1922, the present figures are 216,991 tons less, but they, nevertheless, represent nearly 36 per cent of the total output abroad during 1923. These figures include 7 vessels of a combined total of 66,370 tons to be fitted with steam turbines, and, apart from vessels of less than 1000 tons, 8 vessels of 41,772 tons to be fitted with oil engines. The totals comprise 18 vessels of between 4000 and 6000 tons, 12 of between 6000 and 10,000 tons, 4 vessels of between 10,000 and 13,325 tons, and the Deutschland of 20,602 tons under construction at Hamburg.

The output of the United States for the year 1923, namely, 172,817 tons, was 53,679 tons higher than during 1922, but about 3,903,000 tons less as compared with the record year of 1919, and with the exception of 1922 and 1911, is the lowest since 1898. The tonnage launched represents 17¾ per cent. of the total output abroad for the year 1923. It should be noted that the increase in 1923, as compared with 1922, was entirely due to the larger output on the Great Lakes, where 76,326 tons were launched this year, and only 21,977 tons in the previous year. The total figures include 11 steamers of between 6000 and 9000 tons each, only 2 of which, with a combined tonnage of about 16,900 tons, have been built on the coast, all the others having been launched on the Great Lakes. The totals also include, as previously stated, 8 vessels with a total tonnage of 11,545 tons, which will have oil engines in conjunction with electric motors for the final drive.

The output in France for the year—96,644 tons—was 87,865 tons lower than the total for 1922, and was nearly 41,000 tons below the average output of the three pre-war years 1911–1913. The total figures include 7 steamers of between 5000 and 7700 tons, 1 motor vessel of 8500 tons and 1 turbine-engined vessel of 10,015 tons.

The output in Japan—72,475 tons—was 10,944 tons lower than in 1922. As compared, however, with pre-war years, the present output still exceeds the figures for any year prior to 1914. The 1923 totals comprise 2 steamers of about 6500 tons each, 1 of which will be fitted with turbines, and 1 other turbine-engined vessel of 10,380 tons.

The total figures for Italy—66,523 tons—were 34,654 tons lower than those for 1922. Only 2 vessels of 7515 tons were launched in the Trieste district, while during 1922 the output for that district reached 65,786 tons. The totals comprise 8 vessels of between 5900 and 8400 tons each. Five turbine-engined vessels were launched, with a total tonnage of 30,723 tons, and 1 motor vessel of 5888 tons.

The total tonnage launched in Holland during 1923—65,632 tons—was nearly 100,000 tons lower than the 1922 figures, and was the lowest recorded since 1909. As usual, the figures for this country do not include vessels exclusively intended for river navigation, the total tonnage of which vessels often reaches a very high figure. Only 5 vessels of between 5000 and 7000 tons each were launched, and 1 turbine-engined vessel of about 11,000 tons. The figures included 5 vessels fitted with steam turbines, with a total tonnage of 33,285 tons.

The total tonnage launched in all the British Dominions Overseas during 1923, namely, 41,263, was about 21,502 tons less than in 1922. Of the total figures, 15,260 tons were launched at Hong Kong, 13,998 tons in Australia, and 11,038 tons in Canada. With the exception of the Fordsdale, of 9650 tons, built at Sydney, N.S.W., no vessel of over 3500 tons was launched during the year.

The total tonnage launched in Denmark, Norway and Sweden amounted to 112,216 tons, which total was 8771 tons higher than the output for 1922. In Sweden there was a decrease of 9920 tons, while in Norway there was an increase of 10,228 tons, and in Denmark of 8463 tons. The total figures included 5 motor vessels of between 4500 and 6600 tons, while the largest steamer launched in these countries was of less than 3300 tons. The total tonnage of the steel vessels fitted with internal combustion engines launched in these countries during 1923 amounted to 44,756 tons.

PROGRESS OF SHIPBUILDING ABROAD DURING THE YEAR.

Dealing with the combined totals for the work in hand in the various countries abroad, a steady decrease took place during the whole of 1923. At the beginning of the year the tonnage under construction amounted to 1,485,719 tons, while at the end of December the total was 1,049,155 tons, a decrease of 436,564 tons. Most of this reduction was due to the decrease in the shipbuilding industry in the following countries :—Germany and Danzig, with a reduction of 127,253 tons; Italy, 91,836 tons; France, 77,800 tons; the United States, 47,863 tons; Japan, 30,624 tons; and Holland, 30,158 tons.

The returns for the fourth quarter showed that at the end of 1923 the countries abroad having the largest amount of tonnage under construction were :—Germany, 324,184 tons (excluding Danzig, with 12,440 tons); Italy, 119,663 tons; Holland, 112,811 tons; France, 110,725 tons; and United States of America, 91,585 tons. It should, however, be stated that the above figures referring to work in hand at the end of December, 1923, included about 67,000 tons, on which all work is now suspended. Twelve months ago such vessels amounted to 216,000 tons. To gauge correctly the present condition, and the immediate future of the shipbuilding industry, this factor must be taken into consideration. Another factor which requires to be taken into account is the question of new orders. During the fourth quarter of 1923, the actual construction of 112 vessels, with a total tonnage of 228,000 tons, was commenced, which figures are considerably higher than those for recent quarters. It may, therefore, be hoped that an appreciable change for the better may soon take place in the conditions generally prevailing in the shipbuilding yards abroad.

SUMMARY OF WORLD'S OUTPUT.

The total output during 1923 reached 1,643,181 tons, a figure which represents a decrease of 823,903 tons, as compared with 1922, and of 1,689,701 tons, as compared with 1913, during which year the pre-war world's record output was reached. The output in Great Britain and Ireland represented a slightly lower percentage of the world's output during 1923 than was the case in 1922, viz., 39.2 per cent., but is considerably less than in 1913, when the figure reached 58 per cent.

Some interesting facts are given in the summary regarding the special types of vessels and machinery included in the output of the year under review. The total

launches included 36 vessels of a total of about 304,000 tons which will be fitted with steam turbines. The average tonnage of these vessels reaches 8444 tons. The tonnage of new vessels which are being fitted with internal combustion engines is steadily increasing. During the year under review about 226,000 tons were launched. This total represented about 16½ per cent. of the world's output of steam tonnage for 1923, as compared with less than 9½ per cent. in 1922; and it may be stated that the tonnage of motor vessels being built in the world at the beginning of 1924 represented over 35 per cent. of the steam tonnage then under construction, thus showing the remarkable development which is taking place in the adoption of this system of propulsion.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RAILWAY ELECTRIFICATION.

SIR,—I would ask of you the courtesy of your space to correct the statement in your leader of January 18th that I "discredit the single-phase system on the grounds of telephone interference, &c." The word "discredit" is from the other remark clearly used with the meaning of "prejudice."

I have been closely connected with electric traction matters now for many years and have had a large experience with single-phase work, and am not prejudiced against it, or any system. The opinion I have now formed is that, there being little between systems as regards final costs to transport—what difference there is being against alternating current—that the very large question of inductive interference gives the final weight in the balance to the direct-current side.

The interference matter is a far larger one than you imagine if I understand you aright, and it has never been solved in the sense you suggest. I venture to say that no design of single-phase supply to trains from three-phase feeders could be made which would be sufficiently balanced to prevent severe inductive troubles with near-by parallel trunks; they would have to be removed.

The above is, I feel, necessary for my own vindication, but perhaps I may be allowed to remark that the space taken up by comments on, and apparently agreement with, a calculation of the most economical main line track pressure, the basis being a service of 15 passenger trains in 12 hours each way, on a line 110 miles long, does not indicate a very serious appreciation of the problem to be faced in Great Britain. Possibly, however, Sir, you did not mean the argument and the figures to be taken seriously.

When such a line is electrified it will be to take care of the combined freight, mineral, and passenger service, signalling and lighting, with a load factor higher than any now experienced, and 3000 volts will be a sufficient pressure for economical operation. J. SAYERS.

Derby, January 22nd.

[We are glad to note that Mr. Sayers is of opinion that 1500 volts is too low for main line work. He does not, however, attempt to explain how it is that inductive troubles are not considered to outweigh the advantages of single-phase working on the Brighton Railway, and on other important railways on which it is used. Several countries, it is to be remembered, have adopted this system exclusively. In his original letter Mr. Sayers stated that the practice of using the phases separately would be quite impossible, and we pointed out that this conclusion was incorrect. Now he appears to admit that the idea is not impossible, but he opposes the scheme on the grounds of telephone interference. His remarks concerning Major Taylor's calculations do not alter the fact that a direct-current pressure of 1500 volts is too low, and we note with considerable interest that the London, Midland and Scottish Railway proposes to use the highest direct-current pressure it can. —ED. THE E.]

SIR,—I was much interested in the leading article on this subject, in your issue of the 18th inst., but, with the exception that I am quite disinterested in the matter, in the sense that I have no axe to grind, I do not know that any remarks which I might like to make will be of any help in discussing the same.

The sole reason for my interposing in the discussion on Mr. Whittaker's paper on "Rotary Converters" was that a rather iniquitous waste of money—from my point of view—was contemplated, apparently with the sole object of avoiding, at all costs, the use of single-phase electrification.

I agree with you that the last word has by no means been said on this latter subject, and feel convinced that if the offending telephone wires were put into a cable and suitably twisted, then lead-sheathed and the cable armoured with soft iron wires, or, better steel, with iron tape, the great bulk of inductive interference—both electro-static and electro-magnetic, certainly the former—would disappear.

I know of a case where an experimental trial of interference was made by using a pair of telephone wires in a three-phase pilot cable, traversed by a 25-period current, where there was no detectable interference whatever, though the line was 3 miles long, and though—speaking from memory—the telephone cable was not in equal symmetrical relation with the three phases of the pilot wires, which latter were carrying a "circulating" current.

The cost of changing the telephone wires to an underground cable, or even a cable laid on supports alongside the track, would be a mere nothing compared with the gigantic expense which is involved in some of these direct-current proposals.

I may say that, at the date of the discussion to which you refer, I took pains to put myself in touch with one or two of the principal makers of single-phase locomotives, and was given to understand that there was no serious diminution in the efficiency involved by running at 25 cycles, instead of 16⅔—only a matter of 2 or 3 per cent.; and, if so, it would seem practicable—*pace* Mr. Sayers—to supply such a load from existing three-phase generating stations having this frequency.

Coming now to the direct-current aspect of the question, I believe—speaking from memory—that the General Electric Company of America were the first people in the world to demonstrate, on the C. M. and St. Paul Railway, that motor generators could be satisfactorily made to deal with 3000 volts across a single commutator, under the exigencies of extremely strenuous work. It, therefore, follows that a 6000-volt three-wire system, having the mid-point between two commutators earthed, could be employed for direct-current work, provided that the direct-current motors—and switchgear—could be designed to stand up to 3000 volts. This would, for main line electrification, make all the difference in the world, as compared with the cost of a 1500-volt system, which I understood at the time was being seriously proposed; it would, in fact, enable one-quarter the number of sub-stations to be employed.

At the time I raised this difficulty it was alleged that I had considered only the question of main line express traffic, and not the equally important question of goods traffic and of the large amount of local radiating traffic in the vicinity of big towns and their suburbs. This, I am quite prepared to admit, is correct; but what would be the difficulty of having on the same shaft with the motor generator a rotary converter giving a lower voltage, which could be employed for local lines? Why should it be so difficult to provide the locomotives with controllers, which would enable them, for example, to run with two motors in series when on either side of the 6000-volt system, and with the motors in parallel when on the lower-voltage system? Was it not the case that on the Waterloo and City Railway four motors were arranged to be used either in series or in parallel, and have not similar arrangements been adopted elsewhere?

When a driver is passing from the low-voltage system to the high-voltage system, is it not practicable for him to put his motors in series while still on the low-voltage system? He will only run at this lower speed for a few seconds.

If an overhead system be employed, I should have thought that the difficulties would not be serious as regards the actual break in the electrical continuity of the line. Similar troubles are met with on tramway work daily.

A point that seems to be worth considering is that, whereas there is only a trifling difference—1 or 2 per cent.—in the efficiency of a large single-phase motor, made by such firms as the Oerlikon Company, Brown Boveri, and others, and a direct-current motor, yet with the latter, if the low voltages contemplated for main line electrification are ever employed, we may easily find ourselves wasting 15 to 25 per cent. of the energy in distribution, simply with the idea of cutting down the enormous expense which would otherwise be involved in low-tension copper feeders and contact rails.

If I may be allowed to express an opinion, I feel that in your leading article you have quite rightly taken up the commercial side of the question, which is just as important as the technical side, and is, in fact, the determining factor as to whether the equipment of our main line railways will take place. The fact that in countries blessed with water power the capital outlay on the line equipment does not affect the costs in the same serious way does not apply in this country, and, therefore, means must be devised for greatly reducing the capital outlay on the said line equipment.

Birmingham, January 22nd. A. M. TAYLOR.

MARINE HOT BULB ENGINES AND CRANK CASE COMPRESSION.

SIR,—Would any of your readers or manufacturers kindly inform me if there is any firm making hot-bulb engines up to 300 horse-power, having open crank chambers and slipper guides on the lines of steam marine engines, running at less speed than the usual enclosed engine, as now offered by various makers? Our experience over a period of twelve years in the case of sixteen vessels of different sizes abroad, having engines—mostly twin—between 250 and 80 horse-power, is that although the economy in fuel, as compared with steam, is considerable, the net result is by no means as satisfactory as it ought to be, comparing it with our previous steam craft undertaking the same duties.

Our experience is as follows:—

(1) The wages that we have to pay to obtain suitable engineers is very much higher, as we find these engines cannot be run by the average mechanic or trained natives, who were quite capable of running an old-fashioned compound steam job with the good old marine boiler.

(2) Delays due to breakdowns preventing the vessel carrying out its trips to time.

(3) Capital expended in spare parts.

(4) The wear and tear is much greater, and the life of these engines is not to be compared with our old steam jobs or our stationary gas and oil engines of similar power, running at comparatively slow speed. In fact, we have English-made horizontal gas engines that have been running for sixteen years continuously, and are still doing good work.

(5) With our marine enclosed engines having crank case compression, we have experienced the following:—Hot bearings, by far the worst trouble; then defective piston lubrication, due to oil ways becoming choked up; bottom ends running out through oil not reaching the part, owing to the banjo rings not being accessible for inspection; fractured circulating pumps, due to high speed; difficulty of keeping horizontal plunger pumps tight, owing to wear; no means of adjusting the lift of the pump valves, with consequent wear; unequal water cooling in the case of four-cylindered engines; loss of compression in crank cases; nearly all the packing arrangements by different makers have given trouble, and with the majority it takes a considerable time at sea to replace, owing to the cramped space, and to the fact that the job can only be accomplished by feeling for the different gadgets employed to secure the packing. In some cases it is necessary to dismantle the engine.

The following further time-losing operations are to be noted, as compared with steam, although they would be met with in the case of an open crank engine having pump compression:—

Drawing pistons, a much longer job than is generally supposed; cleaning out silencers and exhaust pipes, which if not attended to catch fire; the adjustment of clutches, in most cases because they are not large enough to transmit the power.

These jobs, added to the usual work that one expects in an engine-room, causes the vessel to be out of commission for a considerable number of days each year. The fault lies in the designers cramping up the engine to reduce the total length to the minimum, making it extremely difficult to get at parts, even with special spanners, and frequently two or three parts or pipes have to be taken down before something can be got at.

The consumption of lubricating oil is also a big item. The mechanical lubricators employed are far from satisfactory, and require a lot of watching. In some cases the drops have to be watched through celluloid panes, which are difficult to see through in a dark engine-room; hence the attendant may be deceived. Bottom ends, owing to the transmitted heat, warm up so rapidly, should the mechanical lubricator fail, that there is no time to avert a breakdown. The vessel's safety is more or less dependent upon a mechanical lubricator. I have urged that makers should provide at least two separate supplies of oil to each bottom end and gudgeon, so as not to cut off the supply completely should one fail. In the case of one of our foreign-built engines, the makers drive a ratchet lubricator by means of reducing gear, reducing the strokes to one-third engine speed. This lubricator has never given any trouble. Owing to the great heat in the neighbourhood of the gudgeon pins, the oil ways at times become choked up in a remarkably short time, and in order to run no risks it means drawing pistons more often. To do this, the vessel has to retire from service.

I will admit that some of our engines have run for considerable periods free from some of these troubles, when all of a sudden they develop. The watching of these engines, as compared with steam, is much more exhausting to the engine-room staff. The heated air is trying, and should a silencer catch fire, the joints give off oil fumes, making the engine-room unbearable. The difficulty of carrying out repairs, especially where vessels are employed at long distances from engineering shops, is increased by makers employing bastard threads or threaded fittings of intermediate sizes not corresponding to standard taps. Also small brass unions with brazed tail pipes in place of flared joints. The designers seem to forget that a cracked tail pipe may compel the stopping of the main engine.

Notwithstanding some of the advantages that this class of machinery undoubtedly offers, we have decided not to engine any further vessels with hot-bulb engines until we can find a type more suitable for marine requirements.

I should, therefore, be extremely obliged if any firm contemplating the building of open crank hot-bulb engines, two or four-cycle, having gudgeon pins or crossheads away from the heat, will oblige us with particulars.

January 21st, 1924. ENGINEER-IN-CHIEF.

POWDERED FUEL.

SIR,—In proving, as I did in my previous letter, that if the figures given by Mr. Brownlie are to be accepted, the Lakeside boilers must possess the remarkable property of being able to evaporate about 40,000 lb. of water per eight hours without consuming any fuel at all, I used nothing but the data given in Table VIII. of that gentleman's paper. I made no "smoothings" or corrections of any kind, as hinted by Mr. Swindin, and anyone who will take the trouble to plot down the coal used per eight hours against the water evaporated, and then draw the Parsons evaporation line will get exactly the result shown in the diagram you kindly published in your issue of January 4th, page 14.

Mr. Swindin has apparently plotted down some other figures, which do not relate to the tests in question, and which therefore I do not propose to discuss. The figures I have criticised were specially given by Mr. Brownlie "to give a good idea both of the performance of pulverised coal under modern conditions and the elaborate care and attention to detail with which these tests at Lakeside have been carried out." Like your correspondent, Mr. Pochobradski, I do not think Dalmarnock has anything to fear from comparison with Lakeside, when the comparison is fairly made, and it is regrettable that the case for powdered fuel should be injured by putting forward figures which are so questionable.

There is another fact with regard to the five tests in question which seems to demand an explanation from Mr. Brownlie. In four of these tests he gives the temperature of the flue gases leaving the economisers as 168 deg., 196 deg., 205 deg., and 204 deg. Fah. respectively. In his recent book on "Boiler Plant Testing," I find on page 60 the following statement:—"The reason for taking 212 deg. Fah. [for the exit temperature in calculating boiler efficiency] is that this is in practice the theoretically perfect exit temperature of a boiler plant, because if the temperature were 211 deg. Fah., all the water in the flue gases, sometimes as much as 50 per cent. of the weight of the coal, would condense in the flues and render the plant unworkable."

It appears to me that Mr. Brownlie must either withdraw this very definite statement in his book, or else he might be good enough to explain how the engineers at Lakeside deal with 2 tons or more of water per hour in the flue from each boiler.

F. D. NAPIER, M.I.E.E.

Brondesbury Park, N.W. 2, January 21st.

BOGUS SITUATION ADVERTISEMENTS.

SIR,—I regret to find it necessary to discuss a most objectionable form of abuse to which the advertisement pages of the technical and daily papers are being subjected at the present time. It would appear that various forms of agencies put in nice-looking advertisements for posts which do not exist, for the sole purpose of obtaining a list of engineers, like myself, seeking re-engagement. As I often receive numbers of circulars from unknown firms, I at first concluded that my address had been obtained from one of the lists of members of the three institutions to which I belong, as these means are often used to broadcast circulars.

A firm of publishers write offering books to assist me in the future, and very kindly advise me that owing to present circumstances they will allow me an extra discount, &c.

The limit is reached when I get a letter asking for details, stating that my name has been put forward by an agency—I regret I have been unsuccessful in obtaining the name of this agency. This is a nice state of affairs, as it is impossible to tell how far they are hawking your services, and what damage it might do to engineers like myself who have always obtained their engagements upon their past records and merit out of a crowd of many hundred applications.

There is no doubt that the publishers of this, or, in fact, any other respectable paper would not tolerate this abuse, and I suggest in future that any reader who receives these circulars should send them to the editor, stating the advertisement to which he believes they refer. This will enable some action to be taken, as I am sure revenue is not desired from this class of advertisement.

January 21st. DISGUSTED.

DOUBLE INLET DROWNED DRAINAGE PUMPS.—In connection with the article on a new type of double-inlet centrifugal pump, made by Gwynnes Engineering Co., Ltd., Hammersmith, which appeared in our issue of January 11th, we are asked to state that the pumps in question were supplied to Vickers, Limited, Hydro-Electric Department—the main contractors for the equipment of the irrigation scheme being carried out by Sir Ganga Ram at Renala, near Amritsar, Punjab. The makers also wish us to point out that the method, we described, of conveying the water to both sides of the balanced impeller is protected by British and Overseas patents.

Electric Lifts.

IN view of the fact that comparatively little has been written on electric lifts, Mr. H. Marryat's paper on "Electric Passenger Lifts," read before the Institution of Electrical Engineers on Thursday of last week, is of exceptional value. The electric lift was first introduced in America, and it is not surprising that American practice has been followed to some extent in this country. Mr. Marryat urges British engineers to carry out investigations with a view to developing lifts more suitable for the conditions prevailing in the United Kingdom, and a number of problems that require investigation are referred to. Another matter to which the author directs attention is that very frequently architects do not consult the lift makers before they set out to design buildings. Higher

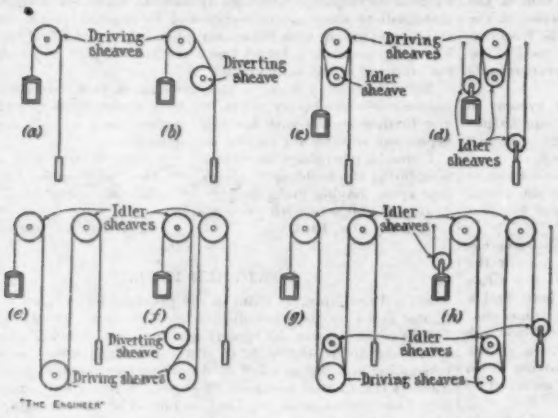


FIG. 1—ROPE ARRANGEMENTS

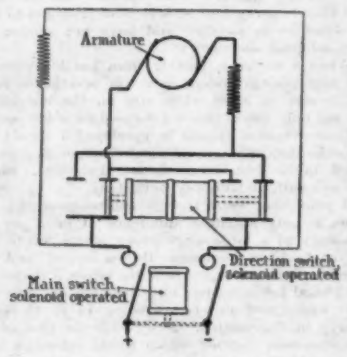


FIG. 2—CONTROL PANEL CONNECTIONS

siderations of economy, because the smaller the diameter of the driving sheave the less expensive are the motor and gear, or because the distance between the car and counterweight centres is too great to be conveniently spanned by a single sheave, or in order to comply with the particular building plan. Arrangement (*c*)—sometimes termed the "full-wrap drive"—may be employed where the out-of-balance load is considerable, and there is danger of rope slip on the driving sheave. It is possible with this method of reeving to employ U grooves instead of the usual V grooves on the driving sheave, thereby greatly reducing the wear on the ropes. With this arrangement the idler sheave may be so placed—as in case (*b*)—as to act as a diverting sheave in cases where the driving sheave cannot be designed to span the distance between the car and counterweight. Arrangement (*d*) shows an adaptation of reeving which may be applied to (*a*), (*b*) or (*c*), introducing a 2 : 1 reduction in car speed. This method, and a further extension of the same principle, may be conveniently employed when very heavy loads have to be raised at low speed. It will be noticed that in this diagram is introduced for the first time an S or backward bend in the rope. Such bends should be avoided where possible, as they are much more destructive than a series of bends in the same direction.

Diagrams (*e*), (*f*), (*g*) and (*h*) show similar arrangements, but with the winding engine at the foot of the well. In these arrangements the lengths of the ropes are greatly increased, and S bends are introduced in every instance. The arrangement with diverting sheave shown in (*f*) is, for some reason which the author was not prepared to explain, exceptionally destructive of the ropes.

Whatever system of reeving is employed, the larger the diameter of the sheaves used, the longer will be the life of the ropes. In these diagrams only one rope is indicated, but it must be understood that in passenger lift practice from four to six or more ropes running side by side are employed.

It will be seen that the winding engine may be placed at the head of the well directly over the work, at the foot, or on any of the intermediate floors. The advantages claimed for placing the gear at the foot of the well are:—(1) Greater accessibility; (2) greater rigidity and therefore longer life; (3) less likelihood of nuisance due to noise and vibration.

In practice, the author finds these advantages largely non-existent, whereas the disadvantage of employing ropes of at least treble the length is of course very evident. Not only is the cost of ropes and of re-roping increased on account of this greater length, but the wear of the ropes is also increased by the larger number of bends—often 8 bends—which the ropes must make.

It is true that under certain circumstances the wear on the ropes can be reduced by so arranging the position of the winding engine that that part of the ropes which passes over the driving sheave does not also pass over the top or other part of the control system may, under certain circumstances, allow of uncontrolled movement of the car.

Towards the end of the paper the author describes the Scott decelerator, which is shown in Fig. 3. The first diagram (*a*) shows the normal arrangement of a direct-current motor (compound wound), to the armature of which a winding drum is attached, and having two unequal weights suspended by cables therefrom. If we imagine the armature rotating in a clockwise direction, and the machine being started up in the usual way, it will readily be appreciated that on the current being switched off the armature will be brought to rest rapidly, the load L′ being considerably heavier than the load L″. If we now imagine the armature rotating in an anti-clockwise direction, on switching off the current the load L′ will continue to exert a rotating torque on the armature

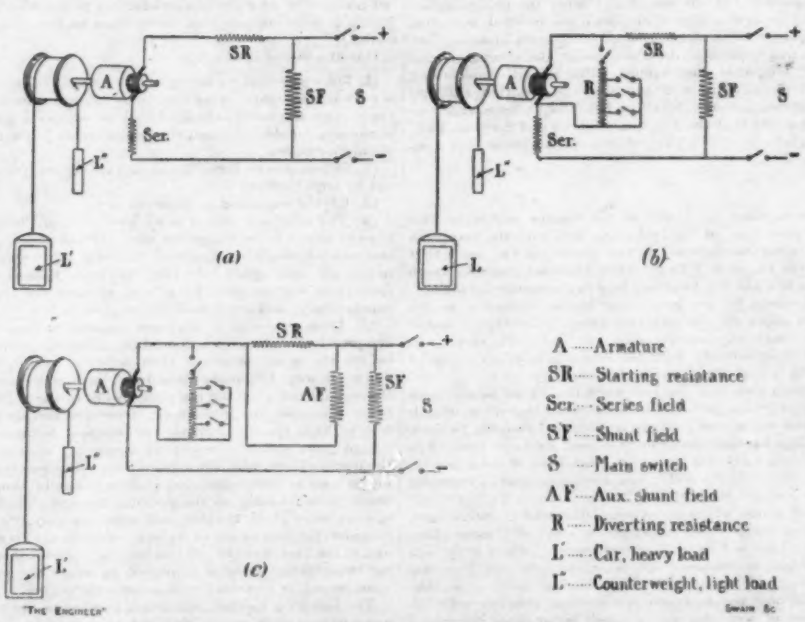


FIG. 3—CONNECTIONS FOR SCOTT DECELERATOR

running speeds and improved acceleration are considered to be desirable and in this connection, the author describes an interesting investigation on acceleration problems. A comparison is also made between drum and sheave driving, whilst the effects of the position of the winding engine and of rope reeving upon maintenance cost are discussed. An important part of the paper is that devoted to safety devices employed in connection with passenger lifts.

There is a tendency, the author states, to increase the speed of tube railway lifts to meet the desire of the travelling public for faster travel. A lift service, however well run, compares unfavourably with an escalator service, and lifts have been replaced by escalators at a number of stations. No lifts at all are provided on the new stations north of Edgware-road, a convenient escalator system having been introduced. For all shafts of a depth of 60ft. and under, the escalator provides a better means of transport, but for a shaft above that depth, high-speed lifts are desirable.

The winding engine giving motion to the ropes may be fitted with a drum to which the car and counterweight ropes are positively attached, or with a V groove sheave transmitting motion to the ropes by friction, as a pulley does to a belt. Serious danger attaches to the drum method of driving, inasmuch as in the event of overrunning and the failure of safety devices the positively driven ropes will cause either the car or the counterweight to crash. With sheave driving, the effect of overrunning and failure of the safety devices, is to land the car or counterweight upon the final stops at the foot of the well, and with the ropes thus relieved of load the gear can continue to revolve until the ropes are worn through, which will take many hours—or days.

The cost of maintenance of an electric passenger lift in business premises, the author goes on to explain, varies from about £20 to £100 per annum, and is largely affected by the frequency of re-roping. The cost of re-roping is largely made up of labour, and is often augmented by the necessity for overtime work; but, apart from the actual cost of the ropes and work, a further loss must be taken into consideration in respect of the discontinuance of lift service whilst the work is in progress.

A prime consideration in the selection of a lift should therefore be the ultimate maintenance cost, with particular regard to re-roping, and to accept tenders for lifts without this consideration is to place a premium on inefficiency.

Frequently, the breaking strain of the ropes to be employed on a new lift is specified without regard to the fact, supported by lift engineers having long experience of maintenance, that a rope of less tensile strength, of the super-ductile class, will in many cases give better results over a number of years. If such ropes are to be employed, care must be taken in the first instance that the lower breaking strain is compensated by larger, or additional, ropes, to provide the necessary factor of safety. Both lift and rope makers differ in their advice as to the most suitable rope for use in any particular case. The author's experience suggests the use of a super-ductile steel for ropes which fail on account of damage by bending, and a hard steel of high-tensile strength for lifts on which the ropes fail from the frictional wear due to slip between the ropes and the driving sheave.

A most important factor affecting the life of ropes is the method of reeving employed. The option to select the best method is often taken out of the hands of the lift maker by the architect, who advances his plans too far before the details of the lifts are considered, and imposes hampering restrictions.

In Fig. 1 are shown diagrammatically the methods of reeving more usually employed, in (*a*), (*b*), (*c*) and (*d*) the winding engine is shown at the head of the well, and in (*e*), (*f*), (*g*) and (*h*) at the foot.

The ideal arrangement is indicated in (*a*), in which th driving sheave spans the distance between the suspension points of the car and counterweight. Arrangement (*b*) is not so satisfactory, but may be necessitated by consheaves and *vice versâ*; but even where this is done, unless diverting sheaves can be eliminated, the wear is greater than with the plain see-saw arrangement with the winding engine at the top.

The increased cost of maintenance due to a bad roping scheme may easily be sufficient to justify several hundreds of pounds capital expenditure in the first place, and may be avoided altogether if proper provision is made in the original plans.

One objection which architects and builders occasionally advance to the placing of the winding engine at the top of the building, is the increased weight on the upper structure. Examination will show that there is nothing in this argument except in the very unusual event of the winding engine weighing more than the combined weight of the car, load and counterweight. Under all other conditions the strain upon the upper structure is greater if the winding engine is placed below.

For low-speed lifts, such as are usual in this country, it is essential to interpose some form of gearing between the motor and the driving sheave. Many types of gearing have been tried, but the worm and wheel is almost universally employed because of its many advantages for this particular work. The advantages advanced by advocates of the under-worm type are, first, that the lubrication is more perfect, and secondly, that any wear taking place in the main shaft bearings allows the gears to drop closer into mesh instead of drawing the worm and wheel apart. On the question of lubrication it is true that with the over-worm type gear the worm is not running immersed in oil, but oil more than sufficient to provide ample lubrication is brought up by the hollow teeth of the wheel. If the inspection cover of such a gear be inadvertently removed whilst the gear is running, it will quickly be replaced to staunch the flood of oil which is thrown by centrifugal force from the worm. The gear case is so designed that this oil thrown from the worm is collected in gutters and conveyed to the worm and main shaft bearings, whence it finds its way back into the reservoir, which is kept filled to a height some inches above the teeth of the wheel. With this type of gear the main shaft bearings, which are the most important in the whole machine, are subjected to a continuous flow of oil passing through them. The answer to the second point is that if the main shaft bearings wear so much as to make an appreciable difference in the mesh of the gear it is time for these bearings to be re-bushed. To meet extreme cases where no backlash of any sort is permissible between the worm and the wheel—these cases do not, in fact, concern lifts, but occur in certain pumping problems—a device of wedges below the main shaft bearings is introduced, by means of which very fine adjustment of mesh can be obtained.

The author pays considerable attention to the push-button and car-switch systems of control. Fig. 2 shows a control panel which Mr. Marryat uses, and is employed with either the push-button or car-switch method of control. With this controller the shunt field of the motor is always left connected across the armature when the main current is disconnected. This arrangement entirely eliminates failure due to inductive discharge on opening the field circuit, and another valuable feature is that the controller is of the double-pole type, the main source of supply being switched on and off at both poles at each operation of the lift. This eliminates a most insidious form of fault inherent in almost every other form of controller, in which an earth developing on one

shaft, thus prolonging the period of deceleration.

Fig. 3 (b) is a similar arrangement, except that a resistance R is arranged in parallel with the armature, a switch being inserted to throw this resistance in or out of circuit.

Now consider the case of the armature revolving in a clockwise direction. If, before opening the main switch, we close the diverting resistance circuit, the voltage across the armature terminals will be reduced, thus causing the motor to decelerate to any predetermined minimum governed by the additional short-circuiting switches on the resistance R. The motor may be finally brought to rest by opening the main switch S.

If the motor be running in an anti-clockwise direction, the preponderance of the weight L′ may cause the motor to generate current. Closing the diverter resistance circuit will put a load on the armature, and additional short-circuiting switches will cause the machine gradually to decelerate as before until the main switch S is finally opened for stopping the machine.

It is found that by correctly calculating the diverting and starting resistances the motor deceleration may be accurately predetermined and will be practically independent of varying loads. An improvement is shown at (c), which illustrates the motor wound with an auxiliary shunt field connected in parallel with the starting resistance. This has all the starting advantages of a heavily compounded machine without the consequent disadvantage of speed variation, the auxiliary field being automatically cut out as the starting resistance is short circuited, and being again automatically strengthened as the armature voltage is reduced by the decelerator resistance.

A further development of this idea with special relation to automatic lifts permits of comparatively high running speeds being employed with the surety of accurate floor levelling under all conditions of load. The design, which is termed the "Auto-Pilot," has only recently been protected, and is in the experimental stage. Two knobs, or large buttons, in the car are marked distinctly "up" and "down." On one of these being depressed the lift accelerates and runs at normal speed. As the car passes each floor a signal light glows, and if the knob or push be released during the period of illumination, the car will decelerate and stop level with the next floor.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Improvement Jeopardised.

THE strike of railway locomotivemen and the threat of labour conflict in the coal mining industry are helping to impair confidence and damp enterprise, and should these elements remain long with us the trade improvement, which is now getting a footing in the Midlands and Staffordshire, will be seriously jeopardised. Already blast-furnaces are beginning to find difficulty in securing supplies of fuel, and engineering firms are having recourse to road transport to keep up their supplies of materials, for nowhere to-day are there large stocks. The unsettled political outlook is also having an adverse effect upon industry in this district. Consumers are disinclined to add to their commitments further than will suffice for immediate requirements, having misgivings as to the durability of demand, and being, moreover, hampered by the low prices at which continental exporters are offering some descriptions of material. Producers, on the other hand, do not care to risk much on forward transactions, having regard to the difficulties that have arisen respecting fuel supplies, and which circumstance are combining to accentuate this week. Coke is dearer. Gas coke is not to be had except in small quantities, and this throws an additional strain on the already inadequate supply of furnace coke. Coal, too, has gone higher, and some manufacturers are not a little anxious as to how they are to get deliveries—even if the strike on the railways does not last—to keep plants going. In the circumstances big contracts are avoided. In the engineering branch orders which are coming along are declared to be accepted at such cut figures that the business is often hardly worth accepting. Certain makers of specialised pumps in this district state that while their order books are certainly better than they have been, prices are being cut to an absurd degree, and one firm suggests that the position is such that some form of protection will be required in face of the severe undercutting from abroad. Continental quotations for both iron and steel have this week been further cut, with the result that native makers of steel billets have been forced to concede a few shillings per ton to secure orders. Consumers now are waiting for further breaks in home prices.

Raw Iron Situation.

The wants of pig iron consumers appear to have been satisfied for the time being, and the market in this department is showing but little expansion, though supplies are being taken regularly against purchases already made. The furnaces are disposing of their output without much trouble, but furnace owners are disappointed at their inability to get better prices. Profits in pig iron making are being cut more finely through the higher price of coke and of fuel generally. In no department of the fuel market is there any sign that the tension has been relaxed, and everything points to still higher prices. Coke values have been accentuated this week, and the strike on the railways has caused considerable delay in delivery of fuel to Midland furnaces. While, therefore, manufacturers are asking for cheaper raw material, production costs are rising. The recent effort to improve, to the extent of 2s. 6d. per ton, late selling rates for pig iron has been only partially successful. Good grades of Derbyshire No. 3 foundry iron command rather more than £4 15s., £4 16s. 6d. at furnaces being a figure much mentioned this week. The Northamptonshire price is round about £4 13s. 6d., while North Staffordshire makes command £4 17s. 6d. upwards. Forge qualities are selling at Derbyshire £4 8s. to £4 10s., Northamptonshire £4 7s 6d., and North Staffordshire £4 10s. upwards. For the first time for many months foreign competition is invading the pig iron department. Makers of pig iron in Cleveland report that foreign iron is being dumped on Teeside at prices 10s. per ton below those quoted by local furnaces. The Midlands are not subject to the same competition, because of the high railway rates charged for the carriage of the iron from the seaboard to Midland destinations. But the effect of the foreign competition is to weaken the market generally. The internal difficulties which beset the pig iron industry, however, cause more anxiety than the probability of any renewal of the continental invasion. Up to now it is understood the consignments of foreign material have been very small. In this connection it is interesting to note that the total imports of pig iron last month did not reach 4000 tons, and the greater part was special foundry iron from Sweden. Exports of pig iron amounted to 46,824 tons, as compared with 47,437 tons in November. Of the total Belgium took 8536 tons, France 3929 tons, Italy 5970 tons. That raw iron production is increasing is evidenced by the fact that during the last three years exports have risen from 103,214 tons in 1921 to 651,079 tons in 1922, and 725,826 tons in 1923, while imports have dropped from 673,824 tons in 1921 to 153,566 tons in 1922, and 90,556 tons in 1923.

Foreign Competition in Steel.

The chief item of interest in the steel market is the keen competition in half-products. Internal competition and pressure from outside have led to further irregularity in prices here. Makers who were quoting £8 10s. for mild steel billets and sheet bars are now quoting £8 5s., and in some cases as low as £8 is mentioned as a basis for business. The low continental prices are definitely attributed to the severe slump in the franc value. Belgian 2in. billets can be bought at £6 17s. 6d, and blooms at £6 10s. It is reported that a deal in Belgian billets has been effected at £6 4s. and that sheet bars have been offered at £6 2s. 6d. This cheap steel, which has been bought in considerable quantities, has enabled re-rollers to quote their product at slightly lower prices, £10 15s. being a common quotation for small bars, with a similar figure for steel tube strip. Belgian prices are much below those of local producers for finished bars, joists and plates, a good deal of this Belgian material being used in the building trade, just now showing considerable activity. A special line of small bars from Belgium was recently offered at £6 15s. Antwerp, or about £7 17s. 6d. delivered here. This has put a stop to the upward movement of home prices. For some months makers at home have been trying to get prices on a more remunerative scale, and fixed £10 15s. to £11, according to size of order. But it has been impossible to keep the minimum at £10 15s., £10 5s. is fairly common, and even £10 has been mentioned. An encouraging feature of the steel market at the moment is the increased inquiry for structural material, especially for bridge building in connection with the various railways, municipal authorities also taking a hand in this class of work.

Iron for Russia.

Some Midland ironworks are this week stated to have sold bars to Russia. The business is understood to have been done on strictly cash terms and has been accompanied in every case by prompt payment. It is hoped this business will expend. The Staffordshire mills are still awaiting the specifications for bars, plates, &c., called for in connection with the rolling stock contracts in and around Birmingham. Makers of high-grade bars, however, are getting some good orders from the locomotive builders and the works continue busy. Makers generally insist upon the £12 10s. figure for bars of medium quality, the £14 10s. basis for marked bars being also unchanged. Though production costs have advanced it is considered that any alteration in prices now would affect other branches of the finished trade at a time when cheapness is the great desideratum.

Continental Price Cutting.

Bar mills in Staffordshire which produce largely for the Black Country nut and bolt trade have to contend with increased and keener competition from the Continent. It looks as though ironmasters have a very stiff fight before them if they are to maintain their share of the trade in face of this challenge from the Continent. Desperate efforts are being made by all the principal ironmasters in Europe who compete with British makers to force further openings in the United Kingdom. Neutral ground is beginning also to be more firmly contested, and the struggle is likely to be intensified as it goes on. Week after week sees Belgian firms cutting their prices and so widening the already large gap between their selling figure and that of local producers. This week No. 3 bars have been quoted at f.o.b. prices working out at not much more than £8 10s. delivered in the Black Country. This, compares with £11 2s. 6d. to £11 5s., the Staffordshire figure, and £11 10s. quoted by Lancashire producers. For work in which uniformly good quality is imperative manufacturers are willing to pay the substantially higher figure for the home product which they know. As for the rest a considerable proportion of the current business is going abroad, and it is realised that if the depreciation of the franc continues we must be prepared to see even more business going to the Continent. With coke at 27s. 6d. per ton and upwards at ovens and pig iron prices advancing, ironmasters ask how it is possible for them to lower their prices. They are intent rather upon raising them, and in many instances they appear to be letting the foreigner take the business rather than cut their own prices to a level which would leave no margin of profit.

Good Business in Galvanised Iron.

The galvanised iron trade is very gratified at the continued increase in the prosperity of this branch of trade. Much satisfaction is occasioned by the returns of the last year's trade. It appears that the total exports, taking the kingdom as a whole, of galvanised sheets, amounted to the very respectable amount of 602,390 tons, an increase on the previous twelve months of 89,280. The principal markets were :—Australia, 112,197, or more than in 1922 by 12,366 tons ; India, 147,906 tons, an increase on the year of 30,558 tons ; the Argentine, 84,418 tons, an increase of 15,982 tons ; South Africa, 34,858 tons, an increase of 66 tons ; Japan, 19,083 tons, a rise of 1725 tons ; New Zealand, 21,721 tons, a reduction, however, in this market of 1657 tons. Dutch East Indies and Canada also took reduced tonnages, the former by 3130 tons and the latter by 7493 tons.

Edge Tool Industry.

Business in the edge tool industry in the Midlands is quite brisk, and there are signs of improvement all round. India is buying well, and the Brazilian market has opened up a little. Endeavours are being made to develop business with Java and the Dutch East Indies, which has been slack, but is now picking up a little. A satisfactory feature is the fact that some forward contracts are being placed. The manufacturers' position has been improved a little by the easing of the raw material market following the influx of foreign steel.

Coventry Engineering Activity.

The motor and cycle, machine tool, stamping, general and electrical engineering firms in Coventry are all busy. Small car manufacturers, in particular, are so well supplied with orders that night shifts are being worked in numerous instances. The bulk of the output is for home requirements, the movement in export business continuing, but showing no signs of rapid improvement. The buoyancy in the motor and other engineering trades in the city fully confirms the feeling held by manufacturers, as stated by me in my letter of January 11th, that disturbing influences excepted, the year should be a prosperous one for Coventry.

Coal Industry and the Strike.

From the point of view of the coal industry of South Staffordshire and East Worcestershire, the rail dispute is a serious one, and its effects will soon be felt by the coalowners and the miners consequent upon the difficulty in getting supplies of coal trucks. At Cannock Chase special efforts have been made to get a good supply of empty trucks, but these will soon be absorbed, and unless further trucks are forthcoming there is a likelihood of the pits being brought to a standstill. Up to the time of writing no special arrangements for the sending of coal by canal would appear to have been made by many local collieries.

Unemployment.

For a few weeks the returns issued by the Ministry of Labour in relation to unemployment in the Midlands have shown an upward tendency. The latest returns, however, show a welcome decline, the number of persons unemployed having fallen from 161,119 to 157,671. The total is made up of 111,794 men, 3560 boys, 37,406 women and 4911 girls. To the total, the Birmingham area contributes 39,541, as against 40,862 a week previously. Bilston contributes 3440 ; Coventry, 3002 ; Cradley Heath, 5000 ; Dudley, 4735 ; Northampton, 2091 ; Oldbury, 1827 ; Smethwick, 4701 ; Stourbridge and Brierley Hill, 3603 ; Walsall, 5966 ; West Bromwich, 2748 ; and Wolverhampton, 7898.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THE general position of the markets, both for ferrous and non-ferrous metals, is not so good as was expected at the beginning of this month. Anticipations of a steady revival of trade were strong up to the time when the holidays interrupted business, and people are now looking round to discover what causes are tending to falsify these anticipations. Some blame politics, and attribute all the uncertainty and want of activity to the fear of a Labour Government, and this feeling is particularly strong amongst those who had hoped —before the election—to see a Protectionist Government in power. There would then have been less anxiety as to the increasing competition of cheap foreign iron and steel. Others blame the financial fears which have arisen, and the slow depreciation of the value of sterling. Probably, however, what stands in the way of revival more effectively than anything else is the general poverty of the whole world. There is urgent need for new machinery, but there is little surplus wealth with which to buy it.

Metals.

The copper market has shown very little movement during the last week. The price for standard copper has moved round about £60 per ton for some little time, and even if no improvement takes place in the statistical position of the metal, it is difficult to believe that lower prices can be expected. It is obvious that £60 is a much lower value in itself than it was when the American Exchange stood at 4.65. Nevertheless, consumers of copper do not yet buy at all freely as they should do if they were convinced that the market was at the bottom. Some orders for locomotives have been distributed in this district, but work on these will have to be considerably advanced before the metal orders come in, although in the present state of the copper market it might be well to anticipate the time when the metal will be actually needed. There is a lack of work amongst the smaller brass and copper foundries of the district ; and this is shown by the indifference to cheap offers of old metal. Dealers here still complain that they cannot find a market for old metal, and offer only very low prices when buying. The movements in tin has been upward recently, and

the price anticipated here some two months ago, viz., £250 per ton, has been passed; but, of course, as in the case of copper prices, some allowance must be made for the depreciation of sterling. The large consumption of tin in the tin-plate trade, both here and in America, but particularly in the latter country, is steadily eating into reserve stocks. At the present rate of consumption—and assuming that the current output will not be increased—the reserves of tin will be exhausted at about the end of this year. The market would then be faced with a difficult situation. It is, however, a little too early to speculate upon what might happen then. The great strength of the market for lead has been maintained so far, and business has remained active at the higher prices. The situation in Mexico was the occasion of the recent advance; but there was also some trouble pending with regard to the output of Australian lead. The United States Government has already sent two warships to Mexican waters; but one cannot say whether this will result in facilitating exports of lead. It seems fairly clear that the market is not in a position to do with any shortening of supplies. The price of spelter has remained steady, but the outlook in regard to this metal is not altogether clear. The world stocks seem to be increasing; but at present there is a fairly good demand from the galvanising trades.

Pig Iron.

The beginning of the railway strike has rather confused the markets here, although it is hoped that the stoppage of traffic will not be long or very serious. Nevertheless, a good many consumers for pig iron are anxious to get stock in their yards; but as most of this has to be delivered against old contracts, it does not mean much new buying. Sellers of foundry iron are still fairly firm, and there is no Derbyshire No. 3 offering at less than 95s. per ton at the furnaces, but the general tone of the market is rather weak, and it is not easy to get a consumer to believe that there is any danger of higher prices. It is, however, quite probable that furnace coke will be dearer next quarter, and makers of pig iron are clear that with an addition to fuel costs there must be an addition to selling prices for pig iron. There is a little Lincolnshire No. 3 iron still offering here at 104s. per ton delivered, but it is not possible to be sure of delivery within any given time, and the few consumers who need supplies of iron are more concerned about prompt delivery than about price. Scotch iron is thought to be a little easier this week, and the Cleveland market also seems easier; but it is difficult to judge of these markets until things settle down again.

Steel.

The demand here for manufactured steel shows no improvement. Both sections and steel plate are rather neglected, although one cannot say that there is any weakening in the prices. The market for sections is more or less affected by the fact that merchants, when they choose, can quote at least 2s. 6d. per ton below the official association price, which stands at £10 for joists and angles delivered in Manchester. Some cheap foreign steel is being offered, and so far as the price is concerned, this ought to be sold quite easily, but there is great doubt about delivery. People have been disappointed a good many times in connection with deliveries of foreign material, and this trade is far from being organised as it used to be. Nevertheless, a good deal is coming into the Midlands.

Scrap.

Dealers here are very much dissatisfied with the state of the trade in scrap materials. There has been a little improvement in steel scrap, but heavy wrought scrap is much as it was; and cast scrap is, if anything, rather more depressed. There is nothing like the demand for it upon which dealers had been calculating a short time ago. Ironfounders buy only sparingly and seem to be able to get all they want at prices between 85s. and 90s. per ton. Some holders of cast scrap still refuse to sell "textile" metal under 95s., but others are weaker.

The Manufacture of Toothed Gearing.

There was a very satisfactory attendance at the meeting of the North-Western Branch of "the Mechanicals" on Thursday, 17th inst., at the Engineers' Club, Manchester, to hear and discuss Mr. Wright's paper on "Gears and Gear Cutting," and it was generally agreed that Mr. Wright handled his subject in a manner that showed how familiar he was with it. By the time he had finished Mr. Wright had demonstrated pretty clearly that the possibility of standardising gear wheels was becoming more remote, for during recent years the tendency of progress seems to have been in the nature of a departure from old practices rather than a development. The precision demanded to-day for high-speed large power toothed gears presents a problem which gear-cutting machine builders are trying earnestly to meet. Moreover, what have hitherto been accepted as standard values, either of pressure angle or working height of the teeth are being ignored, these factors being varied to meet the requirements of each pair of gears. The section of Mr. Wright's paper which proved unusually interesting was that devoted to gear grinding—a branch of the industry that the motor car manufacturer is particularly concerned with. The modern motor car gear-box, although differing but little in principle from its noisy predecessors of twenty years ago, is now generally conspicuous by the absence of noise emitted from it, and the suppression of sound is being attained more and more by short, stiff shafts and case-hardened ground gears. At present the drawback to grinding seems to be the extra cost, but the additional expense should not be so great, as the gears need not be so accurately produced in their early stages. Mr. Wright described the two leading types of gear-grinding machines, and his remarks on them and all the other machines that came within the scope of his paper were evidently based upon practical experience.

BARROW-IN-FURNESS, Thursday.

Hematites.

The railway strike clouds the outlook very considerably, and it is a certainty that if it continues for some time the position in this district will be that of forced idleness. At the time of writing there is a certain amount of fuel available, but unless there is a steady supply the furnaces will certainly have to be rendered idle. Of course, if the condition of the iron trade had been similar to the brisk period when fuel requirements were much heavier than they are to-day, then it would have meant an almost instant stoppage. As to whether coke can be brought by sea is doubtful. Apart from this the general trend of business is improving but slowly—in fact, more slowly than was expected a month or two back. The continental trade is only small, and the amount of business with America is not by any means great. The Midlands are good customers, relatively speaking, and the Scotch demand is likely to increase as soon as the air is clear of labour troubles. It was hoped when the boilermakers came in after their long period of idleness that there would be an end of labour troubles, and that the trade, which had suffered so much, would get a chance to come back to life. Evidently we are not out of the wood yet.

Iron Ore.

The iron ore trade is slow and very little was going out of the district before the strike. Now it will be reduced to nothing. Should there be a general stoppage the mines will immediately be placed idle, and this is unfortunate. The foreign ore is not in great demand and the imports are not heavy by any means.

Steel.

The steel trade remains promising, and there are still orders to be secured, which are likely to keep the rail mills going for some time at Barrow. At the Cumberland rail mills work is about to start, and there is hope that they may run continuously for a period. Before the holidays the amount of orders held were not sufficient to keep the mill fully occupied. The foundries are experiencing better business, and there are more orders in the market. The hoop and section mills at Barrow are fairly well situated for orders.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

THE falling off in new business in the heavy steel branches, to which I referred last week, has been accentuated by the occurrence of the railway strike and by want of confidence in the future. The open-hearth steel plants are still at work busily, though not fully, and are running at about the same level as was the case before Christmas. It is new buying that has dropped off, and this is partly accounted for by cheap continental competition. The general manager of the United Steel Company's Workington works has been giving the Cockermouth Board of Guardians some striking figures as to the way in which France and Belgium are undercutting British prices. He stated that "within the past fortnight one Free State Irish railway company has sent its order to continental works at 25s. 6d. per ton below our price, although we quoted 10s. per ton below cost."

Effect of the Railway Strike.

It is greatly disappointing to Sheffield traders that labour troubles, or anything else likely to cause dislocation, should arise just now, for there is a general feeling that trade is on the mend, and that quiet times are necessary in order that it may be nursed back to complete convalescence. But, in spite of present difficulties, confidence in the future remains. The managing director of one of the largest firms in city, speaking on the eve of the railway strike, as to its probable effect on Sheffield trade, said: "I don't think it will affect the ultimate tonnage produced in the twelve months, but it will create hesitation in the minds of people who were on the point of placing orders, and will hold business back for a period. Things are looking distinctly brighter than they were three months ago, that is, speaking generally, so far as the heavier trades of Sheffield are concerned, a great fillip having been given by the orders of the railway companies. If we could have some settled government for a few years, it would go a long way towards putting us into a condition of prosperity once more." The strike has had little immediate effect on employment at the Sheffield works. Of course, if it continues, they will find it difficult or impossible to get supplies of coal, and will have to close down wholly or partially after a few days; but most of them took steps to lay in stocks of fuel in anticipation of the trouble, and have been able to carry on all right up to the time of writing.

Other Steel Branches.

The railway steel departments continue to turn out a large tonnage of axles, tires, springs and buffers, but no new orders have been reported this week. A fair amount of work is on hand at the steel foundries. There has been a considerable improvement lately in some of the finished steel branches. The increase in the demand for files, already reported, is maintained, and this, together with the better demand for certain other tools, denotes a growing state of activity in the engineering branches. The improvement has not yet extended to engineers' tools, such as twist drills and cutters, but, as the engineers' shops become better employed, these goods will be wanted. The overseas trade in general steel products is much below the normal, but shows a recovery of strength here and there.

A Cutlery Dispute.

Conditions in the cutlery trade vary a great deal, but in the majority of cases makers state that only a poor volume of business is coming in from the ordinary channels of distribution. There is a large demand for table knives of stainless steel, and the recent prosecution for false marking is expected to have a good effect in causing buyers to be more careful in their selection of supplies. A dispute which has arisen between the masters and the grinders, on the question of trough rents, threatens to cause some difficulty in the production of blades. The dispute does not affect all the firms, but about 300 men are out. One firm, which has a large order in hand for table blades for Wembley Park, has already been somewhat handicapped in its execution, because of the shortage of blades. When the men ceased work the stocks of finished blades in the hands of cutlery makers were not large. Several grinding plants in the city, which are capable of a large output, are, however, still working. It is likely that as a result of the dispute increased attention will be given to grinding by machinery. In the electro-plate trade conditions are similar to those in cutlery, and a moderate amount of work is being done. The busiest branches are those which make spoons and forks, for which there is a very good demand from caterers and stores.

Lincolnshire Railway Developments.

The great iron and steel district of North Lincolnshire, which is very busily employed at present, is looking forward with interest to the prospects of considerable railway developments as a result of the new parliamentary powers which the London and North-Eastern Company is seeking. It is proposed to construct, on the Scunthorpe side of the present line, a new railway to join up with the existing one opposite the water cooling towers of the Frodingham Iron and Steel Company. Branching off this is to be another line, connecting with the North Lindsey Railway, behind Messrs. Arnold's mineral water works. The level crossing at Scunthorpe Station is to be abolished. Part of Station-road will be stopped up, and in substitution there will be constructed a new road, which will be carried over the railway by a viaduct or bridge, 145 yards long, at a height of 20ft. above the new rail level. A level crossing at Frodingham is also to be closed, a new road made, and it is also proposed to construct a new passenger station.

Heating of Motor Vehicles.

A simple but ingenious appliance for heating motor vehicles has been brought out by a Sheffield man. Its object is to utilise the heat that is generated by the running of the engine. The Sheffield Corporation is carrying out experiments with the appliance on one of its country motor omnibuses, and on the first trial the temperature was raised in ten minutes from 50 deg. to 64 deg. Fah. The name given to the appliance is "Auto-therm." The heater, which is based on the thermo-syphon principle, is placed on the silencer, taking up half the radius. It is covered with an asbestos jacket within a galvanised sheet. A pipe runs from the heater through the floor of the vehicle to radiating panels, the number of which varies according to the size of the vehicle, and then returns to the heater. When the motor is running the silencer becomes hot, and in a comparatively short space of time the water with which the appliance is filled is heated to circulating point. In this manner it continues to travel round the vehicle and warms it uniformly, in the same way that water-heating apparatus works in large buildings. Should the temperature of the vehicle become higher than is desired, there is a simple apparatus for regulating it, and evaporation is negligible. Mr. William Birchenough, of Millhouses, Sheffield, is the inventor of the appliance, and he and his son have patented it.

British Columbian Steel.

What news is to be had in this district about the reported British Columbian steel combine is of a negative character. It was stated last week that a project had been settled for the co-operation of large British firms with those of British Columbia for the purpose of establishing the iron and steel industry in that part of Canada. The names of several local firms, including John Brown and Co., Davy Brothers, and Newton, Chambers and Co., were mentioned in connection with the matter. Mr. Thomas Miles, managing director of Newton, Chambers and Co., Sir William Ellis, and others have been named as having been elected members of the board of the new combine. Mr. Miles, in an interview, said: "The reports are absolutely inaccurate. Everything is in the air; nothing has been settled. We don't know anything definite ourselves. The whole scheme may fall through, and I think these newspaper reports may have done some damage." It was not denied, however, that negotiations have been in progress between British iron and steel masters and business men of British Columbia.

Orders and Schemes.

The Staveley Coal and Iron Company, Limited, has booked an order for 4000 tons of cast iron pipes for the Hull Corporation Water Committee. The price is stated to be about £35,000. In connection with the two miles extension of the London Electric Railway from Charing Cross to Kensington, an order for £250,000 worth of tunnel segments is to be distributed between works in Sheffield, Nottingham and Glasgow. The contract is said to involve 25,000 tons of material.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Effect of the Railway Strike.

ALTHOUGH at the time of writing there has been no serious dislocation of industry on the North-East Coast, difficulties must inevitably arise in the very near future. There are no present indications that the iron and steel works are feeling the pinch. It is understood that there is sufficient fuel on hand at most of the iron-works to keep the furnaces going in full blast for a few days, and it is not anticipated that fresh supplies will be

completely cut off, at any rate, to those works which depend upon the Durham coalfield. As time goes on, of course, reserves will dwindle, and it is quite conceivable that in a week or so, should the strike continue, ironmasters will be compelled to curtail their activities.

Cleveland Iron Trade.

Very little business has been done this week in the Cleveland pig iron trade, as it was deemed to be useless to place orders with no certainty of delivery. Naturally every effort is being made at the works to get iron away to consumers, but there is greater anxiety regarding the maintenance of adequate supplies of minerals to enable the blast-furnaces to keep going. Up to the present the railway company has maintained a fair mineral service, and there is no immediate anxiety. Any interruption of the flow of minerals would, however, be serious for the ironworks, and the position is being watched with grave anxiety. There is still no foreign market for Cleveland iron, and with the home demand continuing quiet prices have become easier. But, of course, a prolongation of the strike would create a scarcity of supplies and tend inevitably to stiffen prices. No. 1 Cleveland foundry iron is down to 101s., and although quoted at 99s. per ton, a decent order for No. 3 G.M.B. Cleveland might be placed at 98s. 6d. No. 4 foundry has been reduced to 96s., and No. 4 forge to 95s. per ton.

Hematite Pig Iron.

Makers of East Coast hematite pig iron are well situated as regards orders, but they are also finding it more difficult to get new business. They, however, refuse to cut prices, and mixed numbers are firm at 102s. 6d. per ton, and No. 1 at 103s. 6d.

Ironmaking Materials.

Every effort is being made to maintain the fuel supplies to the furnaces. There has not been any attempt to exploit the situation against the ironmaster, though prices are slightly firmer. Good Durham furnace ranges from 36s. 6d. to 37s. per ton delivered at the works. Little business is passing in the foreign ore trade. Best Rubio is quoted at 24s. c.i.f. Tees.

Manufactured Iron and Steel.

The railway strike constitutes another barrier to business in the manufactured iron and steel trade. Already foreign competition had reduced confidence all round, and made buyers cautious, and now comes this industrial upheaval to act as a further check. It is believed that a good deal of constructional steel is wanted, and shipbuilding prospects have improved, but this demand has not yet been translated into business, and is not likely to be until the outlook is less obscure. Quotations are unchanged.

New Coaling Station for the Tees.

Rapid progress is being made with the erection of the new coaling station on the Tees at the Port Clarence Wharf of Dorman, Long, and Co., Limited, and it is expected that it will be put into operation in the course of a few weeks. For some years past the Tees has been severely handicapped by congestion created through inadequacy of the coaling system, vessels having to wait four or five days after discharging for fresh fuel supplies, and frequently having to proceed to the Tyne to coal. The new station will permit of coaling at the rate of 500 tons per hour, and will confer an enormous advantage on existing facilities for bunkering vessels plying to the port of Middlesbrough.

The Coal Trade.

In the Northern coal trade the position is seriously affected by the railway strike. It is feared that the strike will interfere with the carrying out of the large orders on hand for the export of coal and coke, and this has cast a gloom over business on the markets. Trade prospects for the immediate future were fairly bright in the district, and orders for coal had been booked up for months ahead. Should the strike continue for any length of time it will hamper the transport of fuel from the pits to the staiths. The supply of engines has already been reduced at some collieries and at certain shipping staiths, and with fewer locomotives running, shipping is proceeding at a slower rate. Another serious aspect of the dispute is that large vessels due to come to North-East Coast ports will probably be diverted to the Continent. It might also react upon the collieries and lay many of them idle, with the result that American coal would again interfere with British markets abroad. In every branch of the coal trade business is almost dormant, and everything now depends on rail developments. Coal prices are nominal, and all quotations are withdrawn, The strike has had the effect of weakening coke prices, as producers generally have little room to stock production, and, failing this, have to close down. The result is that stocks are large, and offered at low values. Gas coke is nominally quoted at 40s. to 41s., and patent oven coke 33s. 6d. to 36s., but even these prices might be discounted.

SCOTLAND.

(From our own Correspondent.)

"Coming Events."

THROUGHOUT the past week the various markets have been overshadowed by "coming events." The uncertainty of the situation in both a political and an industrial sense, created a deal of hesitancy, and business generally was quiet. The improving tendency in certain markets was arrested, buyers everywhere acting with great caution. The coming of the railway strike, with the accompanying disorganisation of goods traffic, has produced an almost complete measure of stagnation meantime, until the railway companies can put their strike plans into operation, failing an early settlement of the dispute.

Steel Orders Slow.

It is confidently anticipated that a considerable number of orders are almost due to be given out for steel materials, but up to date the amount of new business has been rather disappointing. Specifications for plates are particularly scarce, and sectional material is none too active. Considerable quantities of competitive continental material are on offer at prices a good deal cheaper than home quotations, but local consumers are taking little, if any, advantage of these offers, evidently preferring to hold off, pending a drop in local prices, which they hold is inevitable. Despite a falling off in export demands, steel sheet makers maintain activities, owing to better home orders for heavy gauges. Some of the works are comfortably placed for two or three months ahead.

Bar Iron Busier.

Although still working below normal capacity, the bar iron works are steadily improving their position. Local rolling stock and wagon builders are good buyers, and shipyard orders are becoming more prominent. Re-rolled steel bars are weaker, however. Local prices, however, are still in advance of the figures quoted by English makers.

Poor Demand for Pig Iron.

Quiet conditions ruled in the pig iron market throughout the week. Home consumers are apparently well covered in the meantime, but with prices weakening buyers are inclined to hold off in any case. Export inquiries are few and far between. The price of hematite is unchanged, so far, but foundry qualities are easing.

Coal Prices Firm.

A renewed demand for export coal has caused a firming tendency in prices. Most collieries are well booked for two or three weeks ahead, and most round coals are interested. Washed treble nuts are a firm market. In view of the uncertainty of the position, very little forward business has been done, and then only for very short delivery. Foreign buyers, too, show a disposition to hold off until prices drop somewhat. Shipments from most ports are fairly regular, or were until the railway strike, but considerable delays are experienced at Methil, where a large number of steamers await cargoes. The prospect of a strike caused a rush for supplies on home account. Industrial consumers were anxious to maintain stocks, and there was a regular flood of household orders. Prices of the latter were advanced 1s. per ton, and a common charge was 2s. 6d. per cwt. bag. At the time of writing merchants are already experiencing difficulty in securing deliveries, and a continuance of such conditions will mean dearer prices.

"Red" Miners' Demands.

The latest developments in the coal trade have led to a revival of the Left Wing movement among the Scottish miners. All the Scottish coalfields were represented at a delegate conference held in Glasgow a few days ago, and the following demands agreed upon :—A minimum wage of 16s. 8d. per shift or a guaranteed weekly wage of £3; a six-hours' day; nationalisation of the mines. The delegates pledged themselves to spare no effort to get this policy adopted by the branches, and ultimately by the Miners' Federation of Great Britain. A Scottish Executive Committee was appointed, including one representative from each coalfield, and it was decided to link up with movements of a similar character in England and Wales.

Fort William and Aluminium Factory.

During the course of a lecture in the Town Hall, Fort William, by Mr. C. B. Brook, F.I.C., chief chemist to the British Aluminium Company, it was stated that the negotiations for the development of the Lochaber water power scheme were proceeding in an encouraging manner, and it was hoped that a successful conclusion would be reached in the near future. Prospects of an early start with the laying down of plant at Fort William were promising.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

POLITICAL and, to a larger extent, labour conditions arising out of the locomotive and firemen's strike, have naturally monopolised attention during the past week, to the exclusion almost of coal business, for the reason that operations have come to a standstill. In fact, towards the end of last week when the shadow of the strike loomed, business was adversely affected owing to sellers hesitating to take risks attached to sales under such circumstances, while shipowners were reluctant to charter their ships with the prospect of tonnage being held up in port while the railway trouble lasted. No doubt numbers of steamers have been diverted to continental ports for freights, but such a course was by no means possible for many owners through the fact that their steamships had not sufficient bunkers on board. Most firms at the end of last week received inquiries for immediate cargoes of coal which, of course, they were quite unable to execute, and, in fact, merchants would have been glad to get away some of the ships which were partially loaded at the time of the outbreak of the strike. Until the trouble is over it is very questionable whether exporters will entertain any fresh business as it is practically impossible to say what prices will be like when work is resumed.

Strike on Railways.

There is no doubt that many were surprised to find on Monday that the threatened strike on the part of the locomotive enginemen and firemen was an actuality, as on the Saturday it was pretty freely thought that there would be an eleventh hour settlement. So far as South Wales is concerned the bulk of the Associated Society of Locomotive Engine-drivers and Firemen appear to have carried out their instructions to strike, while the members of the National Union of Railwaymen have so far obeyed their orders to carry on. Considering all the circumstances and the uncertainty as to what men would be available, the Great Western Railway Company has been able to do very well. Attention has, of course, been concentrated upon the maintenance of the passenger and food services as far as possible, so that the movement of mineral traffic has suffered. The services between the most important centres, though of course far below the normal, took something like a definite shape on Tuesday, and it was possible to establish something in the nature of a time-table. West Wales appears to have suffered more than the rest of this district from the point of view of footplate men available and consequently of railway service, and this applies not only to passenger but to mineral traffic. At some of the collieries in West Wales work was brought to a standstill soon after noon on Monday last, and with the passing of every hour the position of other undertakings became aggravated until they were forced into idleness. Some of the steel workers in the Llanelly district were rendered idle as soon as the railwaymen struck work. On the docks the suspension of tipping operations became progressive during the early part of this week. It is impossible to say what engine power the Great Western Company has at the various ports to deal with the movement of wagons; but this may be said, that in the difficult conditions with which the company has been faced more work has been accomplished at some of the docks than was ever expected. It was thought that only the coal on the tip-roads would be available for shipment at any of the docks, and for the most part this has been the case, but there have been exceptions, and coal has been worked down from the collieries. At the same time the number of collieries which have been brought to a standstill through the shortage of empty wagons is fairly large, as is shown from the fact that by Tuesday evening there were over 40,000 miners idle, while that number was likely to be materially increased before the week was much further advanced. Naturally the colliery companies shipped the coal that was available and was on the tip-roads into those steamers which were nearest to completion and upon which there was demurrage being incurred. Owing to the excessive amount of tonnage waiting in dock last week for loading berths, it was the unfortunate experience of some colliery undertakings to have steamers on demurrage before the strike on the railways commenced, so that the steamers in question continue on demurrage as long as the strike lasts, which may be very costly.

LATER.

The passenger railway service in this district has, on the whole, improved, but the position as regards mineral traffic is unchanged. Shipment of coal is on a very limited scale, and there are now between 80,000 and 90,000 miners idle. There are also, approximately, 2000 steel workers rendered unable to work. In the Llanelly district over twenty large steel furnaces have been damped down. Tin-plate works are feeling the shortage of coal supplies, and a number of mills will come to a standstill soon if the position does not quickly alter.

Third Shift Question.

Towards the end of last week the Court of Inquiry, acting as a Conciliation Committee, issued an award as the result of its sittings, and put forward recommendations in order to endeavour to bring this dispute to a satisfactory conclusion. The gist of its recommendations is that the issues involved shall be referred to arbitration, the form of which should be a matter of agreement between the parties. The Great Western Railway Company has formally intimated to the Ministry of Labour that it is willing to adopt the recommendations of the Court of Inquiry, but so far the representatives of the men have not announced their attitude. There was a meeting of the South Wales Area Trimming Board at Cardiff on Monday to consider the whole question as it affects the trimmers, this being in accordance with the reference back from the National Trimming Board, but nothing definite has been made public. After a lengthy discussion the meeting was, in fact, adjourned to a future date, which will be governed by the progress of the negotiations so far as the tippers are concerned.

Copper Trade Workmen's Claim.

The wages question as it affects the men in the copper trade came up for consideration at a special meeting of the South Wales Joint Industrial Council at Swansea at the end of last week, but although the proceedings lasted nearly all day there was no settlement. The men claim that the state of the copper trade has improved sufficiently to warrant an increase in wages, while, on the other hand, the employers hold the opposite view and seek a reduction in wages.

Current Business.

Operations on the coal market have been at a standstill during the past week owing to the strike on the railways, and values are quite nominal. Colliery companies are not prepared to put a price on their coals for shipment immediately after the stoppage as their commitments are very heavy in respect of tonnage which is waiting in dock and which is now arriving. The majority of collieries have sufficient tonnage stemmed to keep them busy for a week at least after the strike comes to an end, and are fully sold in many cases for some weeks ahead, so that they do not expect to have any coals to spare for some time. For any coals that are likely to be available when full work is resumed at the docks higher prices than those ruling last week are almost certain to be demanded. For the time being colliery salesmen are looking on and awaiting events.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 8 9	—
No. 1 Foundry	5 10 0	—
No. 3 Foundry	5 5 0	—
N.E. COAST—		
Hematite Mixed Nos.	5 2 6	5 2 6
No. 1	5 3 6	5 3 6
Cleveland—		
No. 1	5 1 0	5 1 0
Silicious Iron	5 1 0	5 1 0
No. 3 G.M.B.	4 19 0	4 19 0
No. 4 Foundry	4 16 0	4 16 0
No. 4 Forge	4 15 0	4 15 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 10 0 to 4 12 0	
" " Foundry	4 17 6	—
(3) Northampton—		
Foundry No. 3	4 13 6 to 4 15 0	
" Forge	4 7 6	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 4 16 0	
Forge	4 8 0 to 4 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 15 6	—
No. 4 Forge	4 14 0	—
Basic	4 15 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	{5 15 0 (*a*) / 6 0 0 (*b*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best "	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best "	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 2 6 to 11 5 0	
Gas Tube Strip	12 17 6	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 10 0	—
Ship Plates, ¼in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light "	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Hoops	14 10 0	—
MANCHESTER—		
Bars (Round)	10 10 0 to 10 15 0	
" (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
" (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0	—
" (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	13 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
MIDLANDS—		
Small Rolled Bars	10 15 0 to 11 0 0	
Billets and Sheet-bars	8 0 0 to 8 5 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	18 10 0 to 18 12 6	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/9 to 24/3
Block Tin (cash)	251 0 0
" (three months)	252 5 0
Copper (cash)	60 12 6
" (three months)	61 5 0
Spanish Lead (cash)	31 5 0
" (three months)	30 17 6
Spelter (cash)	34 7 6
" (three months)	33 17 6
MANCHESTER—	
Copper, Best Selected Ingots	67 0 0
" Electrolytic	68 10 0
" Strong Sheets	93 0 0
" Tubes (Basis price)	0 1 1
Brass Tubes (Basis price)	0 1 0
" Condenser	0 1 2½
Lead, English	33 15 0
" Foreign	32 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
" 6 p.c. to 8 p.c. "	£22 10 0	8/-
" 8 p.c. to 10 p.c. "	£21 10 0	8/-
" Specially Refined		
" Max. 2 p.c. carbon	£45 0 0	18/-
" " 1 p.c. "	£54 0 0	21/-
" " 0.75 p.c. carbon	£65 0 0	22/6
" carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
" Silicon, 45 p.c. to 50 p.c.	£11 5 0 scale 5/- per unit	
" " 75 p.c.	£18 10 0 scale 6/- per unit	
" Vanadium	20/- per lb.	
" Molybdenum	7/6 to 8/- per lb.	
" Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	24/6
" " Ell	25/6
" " Splint	26/- to 27/6
" " Trebles	25/6
" " Doubles	24/-
" " Singles	21/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	24/6
" " Splint	26/-
" " Trebles	25/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	21/3 to 24/-
Screened Navigation	28/-
Trebles	26/6
Doubles	24/-
Singles	22/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	24/-
Secondary Steam	22/6
Trebles	26/-
Doubles	24/3
Singles	22/-

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	48/- to 59/-
Coke	41/-
NORTHUMBERLAND—	
Best Steams	24/3 to 25/6
Second Steams	22/6 to 23/-
Steam Smalls	15/-
Unscreened	21/- to 22/-
Household	25/- to 28/-
DURHAM —	
Best Gas	24/6 to 25/-
Second	23/- to 23/6
Household	26/- to 28/-
Foundry Coke	45/- to 50/-
SHEFFIELD —	Inland.
Best Hand-picked Branch	35/- to 36/- —
Barnsley Best Silkstone	30/6 to 32/- —
Derbyshire Best Brights	30/- to 32/- —
" " House	26/- to 27/- —
" " Large Nuts	24/6 to 25/6 —
" " Small "	18/6 to 20/6 —
Yorkshire Hards	22/6 to 23/6 —
Derbyshire "	21/- to 22/6 —
Rough Slacks	12/6 to 13/6 —
Nutty "	10/- to 12/- —
Smalls	7/- to 9/- —
Blast-furnace Coke (Inland)	27/- to 29/-
" " (Export)	f.o.b. 35/- to 36/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	29/- to 30/-
Second " "	28/- to 28/6
Best Dry Large	27/- to 28/-
Ordinary Dry Large	25/- to 26/-
Best Black Vein Large	27/6 to 28/-
Western Valley "	27/- to 27/6
Best Eastern Valley Large	27/- to 27/6
Ordinary " "	26/- to 27/-
Best Steam Smalls	21/- to 22/-
Ordinary "	19/- to 21/-
Washed Nuts	29/- to 30/-
No. 3 Rhondda Large	28/- to 29/-
" " Smalls	25/- to 26/-
No. 2 " Large	24/- to 25/-
" " Through	20/- to 22/-
" " Smalls	19/- to 20/-
Coke (export)	52/6 to 55/-
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	28/6 to 29/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 42/6
Seconds	32/6 to 35/-
Red Vein	29/- to 30/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 55/-
Beans	42/6 to 45/-
Peas	26/- to 27/-
Breaker Duff	12/9 to 13/-
Rubbly Culm	13/6 to 14/-
Steam Coals:	
Large	24/6 to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (*a* Delivered Sheffield or Glasgow. (*b*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Economies and Trade.

THE fall in the value of the franc during the week to close upon the low level of 100f. to the pound sterling is likely to have effects of a far-reaching character upon the immediate future of trade. The general public is led to believe that the depreciated currency is due to the attacks of foreign speculators, backed up by political influences, and by thus appealing to national feeling it is nearly certain that the public will give whole-hearted support to the efforts the Government intends to make to strengthen the country's financial situation. It is, of course, perfectly obvious that speculation could not bring about the downfall of the franc if there were no justification in the financial dilemma arising out of a dangerously heavy expenditure and a rapidly increasing fiduciary circulation. As a matter of fact, the Government has been spending money and voting credits on the strength of what it was to receive on account of reparations. Now that the prospect of getting any immediate payment for reparation is becoming more and more remote, the situation is sufficiently critical to damage credit abroad and play into the hands of speculators. The Government has, therefore, found it necessary to take drastic measures in the form of increased taxation, a rigid economy in the State services and the suppression of grants for all purposes that will not bring in an early return for the money spent. For the time being, at any rate, there will be no grants at all. This is bound to affect the engineering and other industries that have been entirely dependent upon the State and public works, on which enormous sums of money have already been spent, while an expenditure of some milliards of francs is contemplated for carrying out various national undertakings. The engineering trades have been looking to this source of work to keep them employed for a considerable time to come. A total suppression of such expenditure would be a serious matter for the home industry, and it is difficult to see how it can be done without involving the risk of an industrial crisis. It may be assumed, therefore, that, while manufacturers will find themselves embarrassed during the period of financial organisation, when the superfluous expenditure will be arrested, the Government will be obliged, at the earliest possible moment, to do what it can to facilitate the putting in hand of public works.

Foreign Boycott.

The industrial resources of the country have so enormously increased that the public works under execution and in prospect, and the demands for the reconstruction of works and factories in the devastated regions, are barely sufficient to keep everyone employed. If much of this business is to be suppressed by State retrenchment, manufacturers will either have to look abroad for work or will have to depend upon the requirements of private consumers at home. It is evidently hoped that it will be possible to tap both sources of demand, for while the fall in the value of the franc should temporarily facilitate an export trade, if only makers dare to take orders during a period of violently fluctuating currencies, an agitation is being created to induce French consumers to abstain from purchasing foreign goods. They are implored not to send any of the despised francs abroad, which would have the effect of weakening the exchange. "Buy French goods and save the franc" is the motto which is being held up before buyers, and manufacturers are trying to convince consumers that they can supply everything required without there being any necessity to seek what they need abroad. At the same time, it is sought to prove that France and the Colonies can produce everything at present being imported from Britain, the United States, and other countries. The agitation is, in fact, reviving the old argument that France can become self-contained and can sell her surplus production abroad; but the commercial community, which has been fighting against this economical fallacy, is bound, in the long run, to secure a recognition of the principle that foreign consumers will not buy French goods unless the French purchase some equivalent abroad. The present effort to ensure a boycott of foreign goods is not likely to have more than a temporary success. The Government is now endeavouring to solve a financial and economical problem which will almost certainly involve a consideration of the commercial relations of France with other countries.

Import Duties and Restriction.

Among the measures which the Government proposes to adopt with a view to stabilising the franc is the imposition of what is practically a tax on import duties; that is to say, the duties will all be increased by an amount calculated to bring in a certain additional revenue. The Government calls this new tax a "protective duty." It is generally supposed that all import duties have a protectionist character, and the further burden is strongly resented by the commercial interests, which regard it as a dangerous fallacy. It is pointed out that the credit of the franc would be better served by encouraging trade rather than by placing fresh impediments in its way. Another measure is to prohibit the importation of goods which are not of national necessity. This will place a particularly dangerous weapon in the hands of the Government.

Helicopters.

In another trial of his helicopter at Issy-les-Moulineaux, M. Pescara easily beat his previous record by remaining in the air 8 min. 13 sec., and he now intends to compete for the prize offered for a circular flight of a kilometre in length. The machine has been constructed largely with subsidies from the Government, which has been encouraging every kind of research work in aviation; but the helicopter type of machine appears to be regarded with far less interest than formerly, on account of the supposedly vulnerable character of an apparatus deficient in speed.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

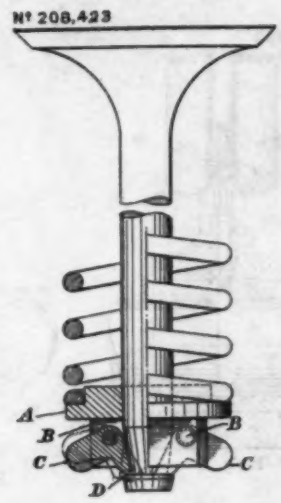
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

208,423. January 31st, 1923.—VALVE SPRING FASTENINGS, C. T. Barnes, 116, Livesey Branch-road, Blackburn, Lancashire.

The object of this invention is evidently to provide a means of securing the valve spring washer without it being necessary to hold the spring in compression in the meanwhile. The washer

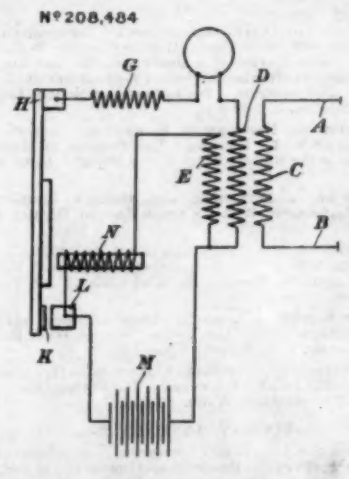


A has projecting lugs B B, between which pawls C C are pivoted. These pawls are so weighted that they tend to close in and engage with the groove D cut in the end of the valve stem. It is obvious that if the washer and spring are pushed up the stem the pawls will engage as soon as they have passed the groove and will secure the washer. A somewhat similar arrangement for inverted valves is described.—*December 20th*, 1923.

TRANSFORMERS AND CONVERTERS.

208,484. June 26th, 1923.—IMPROVEMENTS IN RECTIFIERS FOR ALTERNATING ELECTRIC CURRENTS, Clarence Edward Ogden, of 1740, East McMillan-avenue, Cincinnati, Ohio, U.S.A.

The rectifier described in this specification is distinguished by the fact that the actuating coil of the vibrator is permanently left in circuit with the source of alternating current. A and B represent the two alternating current leads, which are connected with the primary coil C of a transformer. In the transformer, which forms a part of the invention, there are two secondary coils D and E. The coil E may be of smaller capacity

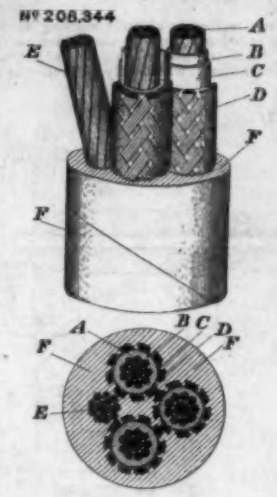


than the coil D. The coil D is connected through an ammeter and resistance G with a vibrator H. The vibrator is provided with a contact K arranged to make contact with a fixed post L, which is connected by means of a wire with one terminal of storage battery M. The opposite pole of the battery is connected by means of a wire with coil D. The coil E is connected by means of a wire with a vibrator coil N, the electro-magnet being arranged to actuate the armature on vibrator H. The opposite pole of the coil N is connected with the terminal post L, and thence through battery with the coil E.—*December 20th*, 1923.

TRANSMISSION OF POWER.

208,344. November 18th, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRIC CABLES, W. T. Henley's Telegraph Works Company, Limited, of 13–14, Blomfield-street, London Wall, London, E.C. 2, and Walter Frederick Bishop, of "Glan Gele," Hurst-road, Winchmore Hill, London, N. 21.

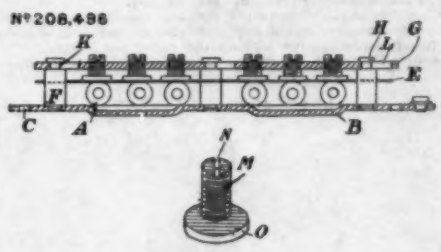
This invention relates to electric cables as used to connect movable electric coal cutters with the nearest fixed source of power, and commonly known as "trailing cables." Three stranded conductors A are each insulated by two concentric layers of insulation B C, the outer layer C being enveloped by a concentric braided conductor D. The sheathed conductors A B C D, together with a fourth stranded conductor E, are assembled into a cable in such manner that the three braided conductors or sheaths D are all in metallic contact with one another and with the fourth or earthing conductor E. The cable thus formed is then covered by a protective sheath F



which may be of solid india-rubber, or of other suitable material, and which may be itself enclosed by braided or other flexible armouring. The cable has the advantage that the several insulated conductors are more effectually protected and that the metallic sheaths are in contact with the earthing conductor throughout the length of the cable. Another advantage is that the improved cable is more flexible than if the conductors were all enveloped by a single metallic sheath of comparatively large diameter.—*December 20th*, 1923.

208,496. November 6th, 1922.—IMPROVEMENTS IN BONDING DEVICES FOR METALLIC SHEATHED ELECTRIC CABLES, Stanley James Bryce, of 75, The Avenue, Leigh, Lancaster, and Callendar's Cable and Construction Company, Limited, of Anchor Works, Leigh.

The invention is shown applied to a continuity bar in which sheathed conductors such as A are threaded over a back plate B perforated at C, so that it can be secured by screws to a floor, wall, or other part of a building construction. A contact strip of metal foil E is then threaded over pins F on the back plate

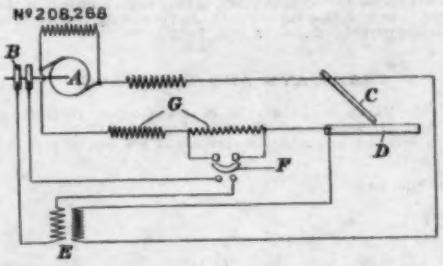


B, and a bridge piece G is then threaded over the pins and locked by sliding longitudinally relatively to the back plate B so that the narrow shank part H of the pins F comes into the narrow end K of the bayonet slots L of the bridge piece G. This bridge piece is perforated and threaded at a number of points to receive a number of set screws M knicked at N to be operable by a screw driver and having mushroom tails O by which pressure can be applied to the conductors A with the interposition of foil E.—*December 20th*, 1923.

MACHINE TOOLS AND SHOP APPLIANCES.

208,268. September 29th, 1922.—IMPROVEMENTS IN DYNAMO-ELECTRIC GENERATORS FOR ELECTRIC WELDING, John Herbert St. Hill Mawdsley, of Danescourt, Barnwood Gloucester.

In accordance with one method of carrying out this invention, a single-armature generator is used, the winding on which is connected both with the commutator A and with the slip rings B. The commutator A is connected with the movable electrode C and with the work D, which constitutes the other electrode. The slip rings B are also connected with the electrodes C, D, the circuit including a transformer E, the primary

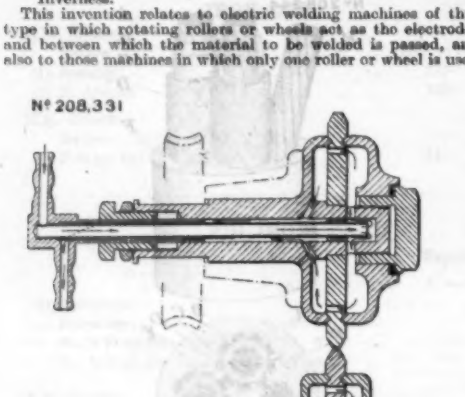


winding of which is connected with the slip rings B, and the secondary winding with the electrodes C, D. In the circuit of the primary winding of the transformer E is a switch F which is opened electro-magnetically when the arc has been struck, the necessary exciting current being derived from the direct current supply. G is a reactance inserted in the direct-current circuit; the reactance is preferably made in two portions, either combined in one coil or separate. The reactance is employed to steady the welding current and to prevent too large an alternating current passing from the secondary winding of the transformer E through the armature winding prior

to the striking of the arc. The left-hand portion of the reactance carries the welding current, and the other portion may be made large enough to carry the alternating current only, in which case the switch F would be so arranged as to short circuit the right-hand portion of the reactance when the arc has been struck.—*December 20th*, 1923.

208,331. November 8th, 1922.—IMPROVEMENTS IN OR RELATING TO ROTARY ELECTRODES FOR ELECTRIC WELDING MACHINES, Samuel Hunter Gordon and the Rose-street Foundry and Engineering Company, Limited, both of 2, Rose-street, Inverness.

This invention relates to electric welding machines of that type in which rotating rollers or wheels act as the electrodes and between which the material to be welded is passed, and also to those machines in which only one roller or wheel is used

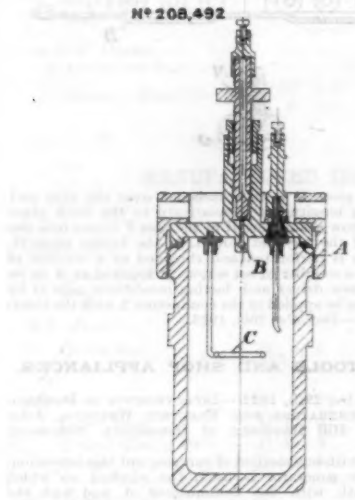


for the same purpose. The rollers are fitted on one or both sides with water-cooling chambers, or jackets, through which the water circulates in the manner indicated, and in which webs, or the equivalents, are provided whereby air is ejected. In the case of two water jackets, one on each side of a roller, one of them may be the inlet and the other the outlet for the water circulation. The jackets and the roller are secured together, and when assembled form a unit connected to a water supply through a hollow spindle.—*December 20th*, 1923.

MEASURING AND TESTING INSTRUMENTS.

208,492. August 13th, 1923.—CALORIMETERS, J. Darrock, 192, Arthurlie-street, Barrhead, near Glasgow.

It appears that the principal claim in connection with this bomb calorimeter is for the use of the rubber ring A, in place of the usual lead ring, for making the cover joint tight. The inventor claims that the rubber is unaffected by the products

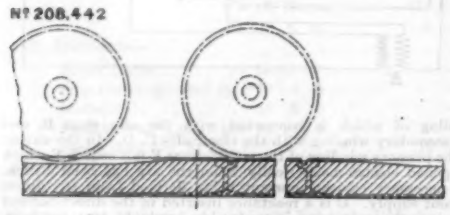


of combustion and thus does not affect the results. There are several minor claims for the mechanical construction of the bomb, which are said to cheapen its manufacture and finally one for the oxygen inlet B. The inlet has a divergent orifice, which is directed towards one side, so that there is no fear of the stream of oxygen blowing any of the fuel out of the crucible held in the support C.—*December 20th*, 1923.

TRAMWAYS AND RAILWAYS.

208,442. March 1st, 1923.—TRAMWAY CROSSINGS, *R. B. Ransford, 24, Southampton-buildings, London, W.C. 2.*

The inventor claims that by the use of his type of crossing,



hammering as the vehicle passes is eliminated. Each crossing is constructed of a single piece, that is to say, it is cast in one or formed of pieces which are welded together to form a single piece and the depth of the groove of each rail gradually diminishes from the normal to a minimum, which is reached just before that rail meets the first of the intersecting rails, and the depth continues at that minimum until that rail passes the last of the intersecting rails, beyond which point the depth gradually increases to the normal. The bottom of the groove of each rail on both the approach and departure sides of the crossing thus forms a gentle slope which may, for example, be 8in. to 12in. long. "As a car begins to traverse the crossing the flanges of its wheels ride up smoothly and imperceptibly on the bottom of the groove, the normal bearing surfaces of the wheels being raised above the rails; the car then runs over the crossing on the flanges of its wheels, and when all the intersecting rails have been passed it gradually descends until the wheels are running normally upon the rails and no hammering occurs." The illustration is self-explanatory.—*December 20th*, 1923.

MISCELLANEOUS.

206,339. November 16th, 1922.—LUBRICATORS, A. H. Ellerman, 111, Winchelsea-road, Tottenham, London, N. 17.

This lubricator is said to be specially suitable for use with a colloidal graphited oil and possesses the advantage that the flow of lubricant is positively cut off when the shaft stops rotating. In the stem of the cup there is a valve A which is operated by the cam B. This cam is formed, as shown in Fig. 2, by springing a strip of resilient material over the shaft and making it excentric

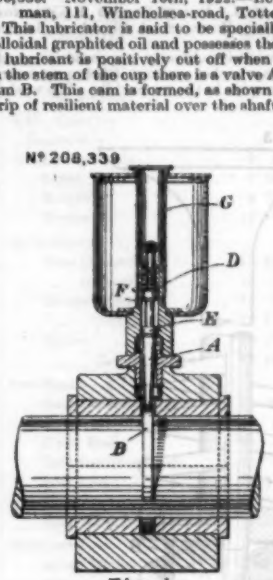


Fig. 1.

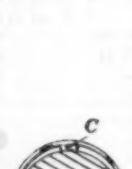


Fig. 2.

by the spacer C. The valve has two pistons D and E, spaced so far apart that the top one D is above the inlet ports F, while the lower one E is within the smaller bore of the stem. When the valve descends the piston D cuts off the supply of oil from the cup, but the amount which has collected between the two pistons finds its way to the bearing *via* the enlarged part of the bore. The sleeve G is for regulating the rate of flow.—*December 20th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Grand Hotel (Windsor Room), Birmingham. Joint meeting of students with the students of the Local Associations of the Institutions of Mechanical and Electrical Engineers. Discussion on "The Influence of Modern Engineering on Civilisation." 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate Westminster, S.W. 1. Lecture, "The Progress of Mechanical Engineering in the Military Service," by Major G. Le Q. Martel. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Holborn Restaurant, W.C. 1. South-Eastern District dinner. 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. Special meeting, lecture on "Molecular Attraction and its Relation to Engineering," by Professor Edwin Edser. 7.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, S.W. Lecture on "Recent Work in Stellar Physics," by Mr. E. A. Milne. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle street, Piccadilly, W. 1. Discourse, "The Future Development of London," by Sir Aston Webb. 9 p.m.

SATURDAY, JANUARY 26TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—London graduates visit to the works of the Power Plant Company, Limited, West Drayton. Train from Paddington, 1.50 p.m.

MONDAY, JANUARY 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Graduates' meeting. Paper, "Brakes," by Mr. C. H. Barker. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-WESTERN SECTION.—Textile Institute, 16, St. Mary's Parsonage, Manchester. Paper, "Some Developments in Electricity Supply," by Mr. S. L. Pearce. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. Cantor Lecture II., "Colloid Chemistry," by Dr. E. K. Rideal. 8 p.m.

TUESDAY, JANUARY 29TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, E. 1. "The Gas Turbine," by Mr. Hugh Campbell. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Some Particulars of the Manufacture of Pneumatic Tires," by Mr. W. Knight. 7.15 p.m.

WEDNESDAY, JANUARY 30TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Chiswick Research Laboratory of the Still Engine Company, Limited.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2.—"The History, Development and Commercial Uses of Fused Silica," by Sir R. A. S. Paget. 8 p.m.

THURSDAY, JANUARY 31ST.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—The University, Edmund-street, Birmingham. Paper on "The Permeability of Concrete," by Mr. H. C. Toy, Stud. Inst. C.E. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "Some Researches on the Safe Uses of Electricity in Coal Mines," by Professor W. M. Thornton. 6 p.m.

FRIDAY, FEBRUARY 1ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. Lecturette on "Torsion Meters," by J. Ward. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse on "Recent Research in Crystalline Structure," by Sir William Bragg, F.R.S. 9 p.m.

UNIVERSITY COLLEGE, LONDON, ENGINEERING SOCIETY.—The College Refectory, Gower-street, W.C. 1. Annual Dinner and Conversazione.

SATURDAY, FEBRUARY 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Grand Hotel, Aytoun-street, Manchester. A lecture, entitled "Some Foundry Reminiscences," by Mr. R. Buchanan, F.R.S.A. 4 p.m.

MONDAY, FEBRUARY 4TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2.—Cantor Lecture III., "Colloid Chemistry," by Dr. E. K. Rideal. 8 p.m.

SOCIETY OF ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, W. 1. Presidential address by Mr. G. A. Becks. 5.30 p.m.

WEDNESDAY, FEBRUARY 6TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Wireless Section meeting. "Atmospherics and their Effect on Wireless Receivers," by Mr. E. B. Mouillin. 6 p.m.

NEWCOMEN SOCIETY.—Prince Henry's Room, 17, Fleet-street, E.C. 4. Various short papers will be read and discussed. 5.30 p.m.

SATURDAY, FEBRUARY 9TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE. Grosvenor Restaurant, Gordon-street, Glasgow. Smoking concert. 7 p.m.

TUESDAY, FEBRUARY 12TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—207, Bath-street, Glasgow. Joint meeting with Institution of Mechanical Engineers and Institution of Locomotive Engineers. Lecture on "Railway Electrification in Foreign Countries," by Professor S. Parker Smith, D.Sc. 7.30 p.m.

TUESDAY, FEBRUARY 19TH.

MANCHESTER METALLURGICAL SOCIETY.—College of Technology, Manchester. Paper, "The Inner Structure of Metals," by Messrs. F. C. Thompson and E. W. Millington. 7 p.m.

WEDNESDAY, FEBRUARY 27TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Queen's Hotel, Birmingham. Annual dinner. 7 p.m.

CONTRACTS.

FERRANTI, Limited, has received an order from the Tata Power Company, Limited, Bombay, for the supply of four banks of 110,000-volt power transformers. Each bank has a capacity of 30,000 kVA. This is claimed to be the largest ever ordered in Great Britain.

CONTRACTS for the reconstruction of the opening bridges over the Waveney at Beccles and St. Olaves have been awarded to the Horseley Bridge and Engineering Company. The new bridges will continue to be of the swing type, but they will carry a double instead of a single line of rails.

FRANK HOW AND CO., of Trogon Wharf, 77–83, High-street, Stratford, London, E. 15, inform us that they have recently been accorded what they believe is probably the most important contract placed in this country since the war, by the Air Ministry for the supply of lubricating oils for aircraft engines.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

G. STREET AND CO., Limited, of 30, Cornhill, London, E.C. 3, inform us that on January 28th they will move their offices to 6, Gracechurch-street, E.C.

SMITH BROTHERS AND CO. (Hyson), Limited, of Hyson Green Works, Nottingham, inform us that they have appointed Mr. A. E. Dickinson their Midland representative in succession to Mr. W. J. Whitby, who has been appointed their Northern representative.

MR. H. A. WATSON, for twenty-three years general superintendent of operation of the North-Eastern Railway and Docks, having recently retired, is acting at 6, St. George's-place, York, for the laying out and economical working of railway accommodation in collieries, factories and business premises.

CUTHILL, KING AND CO., Limited, of 32, St. Mary Axe, London, E.C. 3, inform us that they have recently undertaken the buying agency in this country for:—The New Mauritius Dock Company, Limited, and the Albion Dock Company, Limited, both of Mauritius, and will be pleased to send out any catalogues, &c., which British manufacturers of suitable specialities may care to forward to them. All details should be in triplicate and prices given wherever possible.

INSTITUTE OF TRANSPORT.—The Institute announces that the latest date for the receipt of papers for consideration in respect of current awards is June 30th, 1924. The subjects selected are:—Dock and Harbour Premium: "The Lay-out and Equipment of Quay-side Transit Sheds"; and Water Transport (Canal) Premium: "The Best Way of Obtaining and Retaining Traffic on Canals and Making them Profitable to the Owners and of Service to the Community." It is requested that those proposing to submit contributions will at once so inform the Secretary of the Institute, 15, Savoy-street, London, W.C. 2.